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The effects of two secondary science teacher education program structures on teachers' habits of mind and action

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DEDICATION

To Laura —
God’s timing is perfect. So are you.

To my parents Bob and Vicki —
Your love and support are amazing. I owe you so much in so many ways.

To Greg, Kate, and Josh —
A family of integrity, kindness, and joy.

To Cathlina —
I wish I could be as smart and funny as you.

I love you all.
# TABLE OF CONTENTS

**LIST OF FIGURES**  
vi

**LIST OF TABLES**  
vii

**ABSTRACT**  
viii

**CHAPTER 1: INTRODUCTION**  
1  
  Teaching and Learning: Complexities and Perceptions  
  Teacher Education  
  Iowa State University Secondary Science Teacher Education Program  
  Study Purpose and Research Questions  
  Definition of Terms  

**CHAPTER 2: A REVIEW OF THE LITERATURE**  
14  
  The Unique Nature of Teacher Education  
  The History of Teacher Education  
    Normal Schools  
    Teachers Colleges  
    Universities  
    Alternative Certification  
  The Current State of Science Teacher Education  
    By the Numbers  
    Quality of Science Teaching  
    The University Impact  
  Themes and Trends in Teacher Education  
    Teacher Preparation’s Identity Crisis  
    The Curriculum Debate  
    Ebb and Flow  
    Cycles of Reform  
  Prior Research into Teaching and Education  
    The Education of American Teachers (1963)  
    Places Where Teachers Are Taught (1990)  
    Salish I (1997)  
    Research Recommendations  
  Habits of Mind in the Face of Uncertainty  
    Describing Habits of Mind  
    Developing the Habits  
  Institutional Constraint  
    Elements of Institutional Constraint  
    Loosening the Restraint  
  Basis for the Present Study  

**CHAPTER 3: RESEARCH METHODS**  
121  
  Summary of Study Purpose  
  Review of Research Questions  
  Participants  
  Study Design  

CHAPTER 4: RESULTS AND ANALYSIS

Summary of Problem
Review of Research Questions
Former and Current ISU SSTEP
  Former ISU SSTEP Structure
  Current ISU SSTEP Structure
  Focus and Substance of Former and Current ISU SSTEP Programs
  Significant Differences between the Former and Current ISU SSTEP
  Summary of the Former and Current ISU SSTEPs
Teacher Case Analyses
  Teacher F-1: 4th Year Teacher (Former Program)
  Teacher F-2: 6th Year Teacher (Former Program)
  Teacher F-3: 4th Year Teacher (Former Program)
  Teacher F-4: 5th Year Teacher (Former Program)
  Teacher F-5: 2nd Year Teacher (Former Program)
  Teacher C-1: 3rd Year Teacher (Current Program, MAT)
  Teacher C-2: 2nd Year Teacher (Current Program, MAT)
  Teacher C-3: 2nd Year Teacher (Current Program, MAT)
  Teacher C-4: 2nd Year Teacher (Current Program, MAT)
  Teacher C-5: 1st Year Teacher (Current Program, MAT)
  Summary of Matching between Habits of Graduates and ISU SSTEP
Findings for Research Question 1: Educational Goals for Students
  Summary of Results: Research Question 1
Findings for Research Question 2: Habits of ISU SSTEP Graduates
  Summary of Results: Research Question 2

CHAPTER 5: DISCUSSION AND CONCLUSIONS

Implications
  Abundant Time to Teach and Learn
  Meaningful Content
  Modeling of Effective Teaching
  Dealing with Institutional Constraint
Recommendations for ISU SSTEP
Further Study
Concluding Remarks

REFERENCES

APPENDIX A: LETTER OF CONSENT FOR PARTICIPANTS

APPENDIX B: CLASSROOM OBSERVATION CODING TOOLS
  (1) – LSC Classroom Observation Protocol (COP)
  (2) – Modified SATIC Coding Sheet
  (3) – Classroom Promotion of Student Goals

APPENDIX C: CLASSROOM GOALS STUDENT QUESTIONNAIRE
LIST OF FIGURES

Figure 1: Visual framework illustrating teacher decision-making and their interactions
Figure 2: COP coding for Teacher F-1
Figure 3: SATIC coding for Teacher F-1
Figure 4: Student goals questionnaire results for Teacher F-1 (N = 102)
Figure 5: COP coding for Teacher F-2
Figure 6: SATIC coding for Teacher F-2 (block schedule)
Figure 7: Student goals questionnaire results for Teacher F-2 (N = 50)
Figure 8: COP coding for Teacher F-3
Figure 9: SATIC coding for Teacher F-3 (block schedule)
Figure 10: Student goals questionnaire results for Teacher F-3 (N = 46)
Figure 11: COP coding for Teacher F-4
Figure 12: SATIC coding for Teacher F-4 (one observation)
Figure 13: Student goals questionnaire results for Teacher F-4 (N = 66)
Figure 14: COP coding for Teacher F-5
Figure 15: SATIC coding for Teacher F-5
Figure 16: Student goals questionnaire results for Teacher F-5 (N = 72)
Figure 17: COP coding for Teacher C-1
Figure 18: SATIC coding for Teacher C-1
Figure 19: Student goals questionnaire results for Teacher C-1 (N = 43)
Figure 20: COP coding for Teacher C-2
Figure 21: SATIC coding for Teacher C-2
Figure 22: Student goals questionnaire results for Teacher C-2 (N = 51)
Figure 23: COP coding for Teacher C-3
Figure 24: SATIC coding for Teacher C-3
Figure 25: Student goals questionnaire results for Teacher C-3 (N = 110)
Figure 26: COP coding for Teacher C-4
Figure 27: SATIC coding for Teacher C-4
Figure 28: Student goals questionnaire results for Teacher C-4 (N = 120)
Figure 29: COP coding for Teacher C-5
Figure 30: SATIC coding for Teacher C-5
Figure 31: Student goals questionnaire results for Teacher C-5 (N = 117)
Figure 32: Average student goals questionnaire results
Figure 33: Average observed goal emphasis
Figure 34: Average percentage of initiatory teacher behaviors (SATIC coded)
Figure 35: Average percentage of responding teacher behaviors (SATIC coded)
Figure 36: Average COP coding for ISU SSTEP graduates
## LIST OF TABLES

Table 1: Description of study participants .......................... 125  
Table 2: Required courses and credits (cr) in former ISU SSTEP ........................................... 145  
Table 3: Required courses and credits (cr) in current ISU SSTEP ........................................... 146  
Table 4: Summary of differences between former and current ISU SSTEP .......................... 148  
Table 5: Summary of habits matching between graduates and ISU SSTEP .......................... 323  
Table 6: Number of goals teachers report emphasizing in their classrooms ........................................... 325  
Table 7: Summary of habits matching, overall highlighted ........................................... 333  
Table 8: Percentage of initiatory teacher behaviors (SATIC coded) ........................................... 336  
Table 9: Percentage of responding teacher behaviors (SATIC coded) ........................................... 338
ABSTRACT

This study investigated the effects of the Iowa State University Secondary Science Teacher Education Program (ISU SSTEP) on the educational goals and habits of mind exhibited by its graduates. Ten teachers from ISU SSTEP participated in the study—five from the former program featuring one semester of science teaching methods, five from the current program featuring three semesters of science teaching methods (four for the graduate certification consortium). A naturalistic inquiry research approach included the following methods used with each teacher: three classroom observations, classroom artifact analysis, teacher questionnaires and semi-structured interviews, and questionnaires for students about perceived emphasis of educational goals.

Evidence exists that graduates from the current ISU SSTEP format exhibited a closer match to the educational goals promoted, modeled, and advocated by the science teaching methods faculty. Graduates from the current ISU SSTEP also exhibited a closer match to the habits of mind—understanding, action, reflection, action plan for improvement—promoted and modeled by the program. This study has implications for other secondary science teacher education programs, particularly increasing the number of science teaching methods courses; teaching meaningful content of both concepts and skills through a research-based framework; modeling the appropriate teacher behaviors, strategies, habits, and goal promotion by methods instructors; and addressing issues of institutional constraints experienced by future teachers.
CHAPTER 1: INTRODUCTION

Teaching and Learning: Complexities and Perceptions

American poet Robert Frost (1874-1963) described education as “hanging around until you’ve caught on” (cited in Kaplan, 2002, p. 671). Anyone who has climbed a tree understands that “hanging around” requires perseverance and pain. One must clamber through crooked limbs, brittle branches, jagged twigs, sticky sap, and ceaseless gravity in order to achieve the aspired goal. Analogous obstacles occur in the pursuit of education. While certainly worthwhile and ultimately rewarding, learning is not necessarily always fun.

Education is indeed strenuous and demanding for the learner as well as the teacher (Bransford, Brown, & Cocking, 2000). Classroom conditions are complex and continually changing (Leinhardt & Greeno, 1986). In such a dynamic domain, the teacher must make numerous choices and act accordingly in an effectual manner (Clough, 2003b; Good & Brophy, 1994; Watson & Konicek, 1990).

Public perception does not readily recognize such complexities (Feiman-Nemser & Floden, 1986; Lanier & Little, 1986). Policy makers, scholars, and parents all typically hold beliefs that belittle the role of the teacher: (1) individuals with subject matter understanding are qualified for effective teaching; (2) one can develop proficient pedagogical skills naturally through experience alone; (3) teaching is a matter of personal style; and (4) teaching involves the simple act of passing information from the teacher to student (Clough, 2003b). Even as people hold onto such perceptions, they still expect quality education for the nation’s children.

Many components affect the creation of a productive classroom learning environment. A brief list includes administrative leadership, curriculum, materials and
resources, assessment, technology, student attitudes and backgrounds, and community and family support. While numerous influences define a student’s education experience, the classroom teacher is a primary force in shaping student learning and leading educational change (Berliner, 1989; Cremin, 1961; Duffee & Aikenhead, 1992; Fullan, 1991; Good & Brophy, 1994; Goodlad, 1990c; Penick, Yager, & Bonnstetter, 1986; Sanders & Rivers, 1996; Shymansky & Penick, 1981).

Teacher Education

The countless complexities in effective teaching demand high quality teacher education programs. Despite this need, an ongoing struggle exists to identify and implement teacher education of such caliber. This “persistent nature” is not due to a lack of effort. Teacher education—and its shortfalls—have been studied and scrutinized ad nauseam ever since the dawn of the twentieth century. “Substantial improvement-oriented inquiry and developmental activity have been undertaken since then, although the troublesome circumstances remain basically unchanged” (Lanier & Little, 1986, p. 527). Additional turmoil arises when attempting to arrive at a consensus among teacher educators about the most effective approach to educate future teachers. However, Clough (2003b) argues that much of this disagreement could be resolved if educators would integrate multiple perspectives on learning and eschew isolated research findings in favor of the synergy that results from combining pedagogical practices into a coherent whole.

Educational researchers and scholars often attempt to compare teacher preparation with that of other fields, namely medical education. The paragon to which many ascribe is the nationwide medical school evaluation spearheaded by former high school teacher Abraham Flexner (1910). Sponsored by the Carnegie Foundation, Flexner studied 115
medical schools across the United States and Canada. He found a spectrum ranging from exemplary to shoddy. The ultimate result of Flexner’s study was a reformation of medical education. Research-based instruction and practice became the standard, as opposed to anecdotal and other unscientific bases (Monk, 2004). Future doctors learned medical practices through unified clinical and academic instruction, firmly founded upon standards of merit.

The Flexner Report catalyzed medical education’s change into the cohesive, research-based approach of today. It was not an easy transition, however. In less than a year after Flexner’s published specifications, over half of America’s medical schools ceased operations (Gage, 1972; Goodlad, 1990b). Nevertheless, the long-term effects of the Flexner Report were momentous improvements in medical education (Miller, 1962). Nearly a century later, teacher education finds itself at a similar intersection that medical education had to once cross. “This juncture is where a craft either continues to take its cues almost exclusively from practitioners of the craft or opens itself up to the research and theory of those who inquire into it” (Goodlad, 1990b, p. 30).

Teacher education needs a “self-audit” similar to the approach taken by the Flexner Report. While the education of teachers has not necessarily been ignored, it has certainly been neglected (Goodlad, 1990c; Tyack, 1989). “[I]t has been harnessed and prodded almost to death, yet given little nourishment. Most of all, teacher education has suffered from superficial scrutiny and consequently from inadequate understanding” (Goodlad, 1990c, xii). This misguided abuse stems from faulty diagnosis and prescription. Perennial side effects are stumbling, maladroit attempts at teacher education. It should be no surprise that half of all new teachers quit the field within five years (Goodlad, 1990b), yielding nationwide
shortages of science instructors (Darling-Hammond, 2001; Windschitl, 2005). A conglomeration of struggling teachers results in schools with deteriorating health. Teachers who refuse to hang onto education will result in students who do likewise.

**Iowa State University Secondary Science Teacher Education Program (ISU SSTEP)**

This study will investigate the problem of teacher education through an analysis of the Iowa State University Secondary Science Teacher Education Program (ISU SSTEP) and its graduates. The ISU program experienced changes in course sequence and requirements in the year 2003. Between the years 2000 and 2003, preservice teachers in ISU SSTEP completed a one-semester science teaching methods course. After 2003, preservice teachers completed three science teaching methods courses over three contiguous semesters (those in the graduate certification program completed a fourth methods course after student teaching). Students in the current ISU SSTEP program had additional fieldwork experiences in conjunction with these courses and also completed a required nature of science (NOS) course taught by the same instructor of the science teaching methods courses.

Current program students are given more time to investigate key concepts and applications such as generating a more thoroughly examined and developed set of student goals (including creating lists of student actions for each goal), investigating further into research on how students learn (including constructivist, social, developmental, and behaviorist perspectives), developing and practicing teacher behaviors and their complex interplay (questioning, responding, wait-time I and II, listening, non-verbals, etc.), and learning more about other matters such as safety, classroom management, assessment, curriculum integration and modification. All the while, the emphasis was on developing a
deep understanding of teacher decision-making and making such informed decisions in classroom settings.

Graduates from both ISU SSTEP incarnations received instruction about developing a research-based framework (RBF) to assist them in making decisions regarding science instruction. The same educational goals for students and habits of mind (understanding, action, reflection, improving practice) were promoted, modeled, and advocated by the science methods instructor. The same instructor has taught or co-taught all of the science teaching methods courses since 2000. The primary difference of the two formats is the amount of time preservice teachers have to learn and practice these understandings and skills. If education is truly “hanging around” until the student has “caught on,” one might consider how adding multiple science teaching methods courses will increase future teachers’ development of pedagogical capabilities.

**Study Purpose and Research Questions**

This study intends to add to the knowledge base regarding effective science teacher education. The research reported here is part of a large and ongoing effort by Iowa State University science education faculty and graduate students to study the Iowa State University Secondary Science Teacher Education Program (ISU SSTEP). The overarching study is being conducted to determine the effectiveness of the former (2000-2003) and significantly restructured current (2003-2006) formats of ISU SSTEP. It does not evaluate nor make judgments on the effectiveness of any individual’s science teaching practice. The intent is to compare the effects of the former and current programs; and to determine what the current ISU SSTEP does well and not so well, and how it can be improved. In the end, the comprehensive study will include science teachers who completed the ISU SSTEP from the
spring 2000 to summer 2006 semesters. It will address additional questions about teacher retention, reasons for leaving the teaching field, graduates’ assessment of the general education and science education components of their teacher education program, as well as items examined in this present study, as outlined below.

Both the overall study and this present study make no claims about the impact of ISU SSTEP on 7-12 students’ science achievement. Rather, the focus is on how well ISU SSTEP produces teachers that exhibit the behaviors and understandings modeled and promoted in the program. Specific research questions of this present study fall under two primary categories. As the following questions indicate, the effects of the ISU SSTEP as a whole as well as its former and current formats are investigated:

1. Educational Goals for ISU SSTEP Graduates’ Students:
   a. What do graduates of the former and current ISU SSTEP report are their goals for students?
   b. What do secondary students in the classes taught by former and current ISU SSTEP graduates perceive are the goals promoted in the class?
   c. In classroom observations of former and current ISU SSTEP graduates, what goals appear to be promoted?
   d. How do these results compare to the science education goals modeled, promoted, and advocated by ISU SSTEP faculty?

2. Habits of Mind of ISU SSTEP Graduates:
   a. What habits of mind—understanding, action, reflection, improving practice—do former and current ISU SSTEP graduates exhibit?
   b. How do these compare to the habits promoted and modeled in ISU SSTEP?

The first topic focuses on educational goals for students, similar to the much larger study of schooling led by John Goodlad (1983, 1984). The first topic’s questions connect to the larger issue of topic two, as promotion of student goals is one aspect of the habits of action and understanding promoted by ISU SSTEP for its preservice teachers. Data collected
and analyzed for the first topic help in determining findings for the second topic, the latter being the initial and central purpose of this study and the more comprehensive study as a whole.

The crux of the issue is determining how to effectively prepare science teachers. How might programs cultivate teachers who exhibit habits, understandings, and behaviors that more closely match with those promoted in their preservice methods courses? Such alignment aids the purpose of creating lasting, meaningful change in the education of teachers and children. What is needed to make a greater difference? This, as Sarason, Davidson, and Blatt (1986) observe, is the overlooked, “unstudied problem” in teacher education. With the same teaching methods instructor over multiple semesters, preservice teachers experience and revisit a consistent, coherent approach to education. Expanding the time of preservice teachers’ methods courses forces them to “hang around” longer. The comprehensive study of ISU SSTEP seeks to determine the impact of such changes. This present study will address specific components of the program.

The questions and purpose of this particular study will be revisited—along with a discussion of potential limitations—in Chapter 3: Research Methods. First, one must review past attempts to teach teachers and the accompanying research. A discussion of the historical evolution of teacher education provides insight into common themes, tendencies, trials, and triumphs. Furthermore, it creates a framework for the current study.

**Definition of Terms**

For clarification, the following definitions articulate meaning to the terms used in this study.
**ISU SSTEP:** The Iowa State University Secondary Science Teacher Education Program (ISU SSTEP) consists of science content, general education, and science education courses. *Chapter 4* includes a detailed description of both the former program (one science teaching methods course) and current program (multiple science teaching methods courses). Teachers from both iterations of the ISU SSTEP participated in the study.

**ISU SSTEP Graduates:** These are the teachers who graduated from the ISU SSTEP, either from its former format or current format. They are referred to as preservice teachers when they were in the program before graduating.

**Research-Based Framework (RBF):** A major thrust of ISU SSTEP, which refers to developing a research-based framework to support decision-making when teaching science. Research-based refers to professional practices and understandings that are informed by qualitative and/or quantitative quasi-experimental studies, supported by consensus among science education researchers and scholars, and presented in referred journals or books. A visual schematic of teacher decision-making that guides the RBF is used in ISU SSTEP and appears in *Figure 1* (Clough, 2003c; Clough & Berg, 2006; Clough and Kauffman, 1999). Research-based teaching is consistent with the objectives of the National Science Education Standards (NSES) (NRC, 1996).

**Habits of Mind:** These are characteristics, skills, and understandings of individuals that equip them to make appropriate decisions in the context of teaching and learning (Cook, 1996; Husu, 2002; Kassem, 2005; Meier, 2002; Sizer, 1992). ISU SSTEP advocates, models, and promotes self-designated habits of mind for its preservice teachers. As deemed by ISU SSTEP faculty, categories of the habits of mind emphasized in ISU SSTEP include habits of
understanding, habits of action, habits of reflection, and habits of having and enacting an action plan for improving practice.

**Educational Goals for Students:** Also referred to as student goals or goals, these are the characteristics, understandings, and skills teachers seek to develop in their students. These are the ideal traits students will have after leaving the teacher’s classroom at the end of the school year. Teachers emphasize and promote these goals in their daily classroom lessons and experiences. Examples of goals are deep content understanding, critical thinking, communication and collaboration, ability to use resources, problem solving, etc. These goals are different than lesson objectives in that they underlie every lesson and classroom experience, whereas lesson objectives are specific student actions or achievements for a particular activity or unit.

**Nature of Science (NOS):** The “nature of science” (NOS) refers to the central values and assumptions found in the development of scientific knowledge (Lederman & Zeidler, 1987). It includes what science is, how it works, the foundations of science (epistemological and ontological), the social interactions of scientists, and the reciprocal role between science and society (Clough, 2003a). NOS features a compilation of several fields such as the philosophy, history, sociology, and psychology of science (McComas, Clough, & Almazroa, 1998).

**Local Systemic Change (LSC) Classroom Observation Protocol (COP):** A quantitative coding tool used in observations of classroom teaching. The COP addresses lesson design, implementation, science content, classroom culture, and an overall capsule rating (Banilower, 2005; HRI, 2006) with respect to science inquiry and alignment with the NSES (NRC, 1996).
**Inquiry:** An investigative approach to teaching and learning science content and skills (AAAS, 1993; Clough & Clark, 1994a, 1994b; Lederman, 1998; NRC, 1996, 2000; NSTA, 2004b). Students work through science investigations in a similar manner that real scientists do. Students do not follow a set of laboratory “cookbook” steps. Instead, they must use their prior experiences and understanding to develop an approach to solve a problem or answer a question. The level of teacher guidance varies according to the type of inquiry, decreasing from structured inquiry to guided inquiry to open inquiry.

**Learning Cycle:** A particular teaching strategy that uses the inquiry approach for learning science content and skills (Colburn & Clough, 1997; Lawson, Abraham, & Renner, 1989). Supported by research on learning, the learning cycle approach creates opportunities for student exploration of phenomena through concrete experiences, consolidation of ideas through student discussions about these experiences, and application of the content in which students further develop their understandings.

**Teacher Behaviors:** The decisions and actions a teacher exhibits during the lesson. These include asking questions, posing challenges and problems, responding to student questions and comments, observing and listening to students, using appropriate wait-time I and II, moving around the room to use proximity with students, using non-verbal expressions such as smiling, eye contact, nodding, counting on fingers, writing on the board, and other behaviors to communicate interest, engagement, and excitement.

**SATIC:** The Schlitt Abraham Test of Interaction Coefficients (SATIC) monitors teachers’ verbal interactions and patterns during classroom instruction by recording the occurrences of various question and response types along with non-verbal behaviors (Abraham & Schlitt, 1973).
**Rhetorical Questions, Statements, and Lecturing:** Initiatory teacher talking that are categorized in the SATIC coding tool as SATIC 1 for lecturing (marked once for roughly every 20 seconds of teacher talking) or giving directions, or as SATIC 2 for making a statement or asking a rhetorical question (“So it got bigger, right?”).

**Simple Questions:** Initiatory teacher questions that do not require students to engage in considering their ideas, but rather give a short or one-word answer. The SATIC coding tool has two categories of simple questions: yes/no/dichotomous (SATIC 3a) and short-answer (SATIC 3b). Examples are: “Did the balloon expand?” (3a) and “What is the opposite of condensation?” (3b).

**Open-Ended Questions:** Initiatory teacher questions that require students to think on their ideas and articulate their understandings. Two categories of open-ended questions on the SATIC coding tool are thought-provoking short-answer (SATIC 3c) and extended-answer (SATIC 4) questions. Examples are “What might happen to the balloon if the temperature increases and the pressure decreases?” (3c) and “What might be some ways in which your conclusions compare with the first investigation’s findings?” (4). These types of questions are advocated, modeled, and promoted in ISU SSTEP.

**Teacher-Centered Responses:** Responding behaviors by teachers that limit student engagement and assessment. The SATIC coding tool categorizes these responses as rejecting a student comment (SATIC 5), affirming or praising a student comment (SATIC 7), repeating a student comment (SATIC 8), clarifying or interpreting a student comment (SATIC 9, a.k.a. “putting words into the student’s mouth”), and answering a student question (SATIC 10).
**Value-Neutral Response:** A responding behavior by the teacher that acknowledges a student comment, coded as SATIC 6. This response has been separated from other teacher-centered responses (SATIC 5, 7-10) due to neither rejecting nor confirming the student comment. If used too frequently (“okay,” “all right,” etc.), this form of response can become an annoying mannerism, coded as SATIC 15.

**Student-Centered Responses:** Responding behaviors by teachers that elucidate further engagement, assessment, and/or participation in learners. Two categories of student-centered responses in the SATIC coding tool are asking for elaboration or clarification (SATIC 11) or using a student idea or question (SATIC 12). Examples are “For what reasons might this balloon change size?” (11) and “How does your group’s idea compare with the first group’s findings?” (12). These responses are advocated, modeled, and promoted in ISU SSTEP.

**Wait-Time I and II:** The time of silence a teacher waits after asking a question before repeating the question, asking a different question, or adding further comments (wait-time I); or the time of silence a teacher waits after a student has asked a question or made a comment before speaking (wait-time II). Questioning and responding both reach their full potential for student and teacher thinking when accompanied by appropriate wait-time (Rowe, 1986). The SATIC coding tool records inappropriate wait-time I (SATIC 13a) and II (SATIC 13b), when teachers speak before waiting an appropriate amount of time. For this study, teachers were coded as exhibiting inappropriate wait-time (I or II) when they spoke again before waiting roughly 3-4 seconds after asking a question or after a student made a comment.
**Non-Verbal Behaviors:** The unspoken actions teachers exhibit during their interactions with students among lessons. Examples are smiling, eye contact, moving around the room, body language, counting on fingers, nodding, and additional facial expression and motions. The SATIC coding tool lists inappropriate wait-time I and II as non-verbal behaviors.

**Institutional Constraint:** Barriers teachers experience to using research-based instruction in their classrooms and developing their professional practice. Institutional constraint is both explicit and implicit and exists in multiple forms: overbearing administrators and colleagues, resistant students and parents, restrictive district mandates, insufficient materials and resources, and more (Desimone, 2006).
CHAPTER 2: A REVIEW OF THE LITERATURE

The Unique Nature of Teacher Education

The special nature of teacher education must be understood before exploring its history. Teacher preparation has unique qualities distinguishing it from other professions and endeavors. A primary difference is that future teachers are exposed to the act of teaching from the moment they enter kindergarten as five-year-olds (Lanier & Henderson, 1973). For a decade and a half, they have direct contact with the culture of their impending occupation. Lortie (1975) elaborates on the particular dealings in the classroom:

Those who teach have normally had sixteen continuous years of contact with teachers and professors. American young people, in fact, see teachers at work much more than they see any other occupational group; we can estimate that the average student has spent 13,000 hours in direct contact with classroom teachers by the time [one] graduates from high school. That contact takes place in a small space; students are rarely more than a few yards away from their teacher. (p. 61)

The effects of such intimate contact are powerful. Multiple studies indicate that individuals’ views of learning and teaching roles are established through these years of incessant interaction (Goodlad, 1990a, 1990c; Lortie, 1975; Sarason, 1981; Stoddart, Connell, Stofflet & Peck, 1993).

Unfortunately, most future teachers have not experienced education at its best. For the most part, prospective teachers have sat in classrooms that centered almost exclusively on teaching as telling and learning as regurgitating what was told to them.

Classrooms come to be dominated by particular teaching practices that concentrate on definite content and skills that have to be learned and by student attitudes toward conformity, productivity, and other traits required for minimal participation in social, bureaucratic, and industrial organizations. (Cuban, 1993, p. 16; emphases added)

Postman and Weingartner (1969) provide a key question and vivid observation of the alleged “learning” process in many classrooms:
Now, what is it that students do in the classroom? Well, mostly, they sit and listen to the teacher. Mostly, they are required to believe in authorities, or at least pretend to such belief when they take tests. Mostly, they are required to remember. They are almost never required to make observations, formulate definitions, or perform any intellectual operations that go beyond repeating what someone else says is true. . . . It is practically unheard of for students to play any role in determining what problems are worth studying or what procedures of inquiry ought to be used. (p. 19; emphases in original)

Such exposure to repressive instruction occurs early, lasts through adolescence, and continues into college courses, even including classes in the education field (Goodlad, 1990c).

The classroom culture of passivity is especially detrimental for future science teachers. Craven and Penick (2001) articulate the potential hazards of extended exposure:

As a result, many people construct implicit sets of beliefs about how schools and classrooms should operate—operations that are often antithetical to a culture of thinking, inquiry, and scientific literacy. With teachers, such beliefs manifest themselves in inferior classroom practice. (p. 2)

Adding to this dilemma is the observation that many future educators choose to teach out of a love for a particular subject (Postman & Weingartner, 1969). In fact, individuals who pursue the teaching profession often do so out of a fondness for their experiences in school. “Recruitment, then, brings into the occupation people who tend to reaffirm rather than challenge the school’s role and its current organizational structures” (Cuban, 1993, p. 254).

This cyclic pattern sustains the norm of limited authentic problem solving and critical thinking. As a result, schools remain stagnant. Positive change never truly arrives. Education continues to be “a culture of trivia” (Craven & Penick, 2001) and “a rhetoric of conclusions” (Schwab, 1965).

The hidden curriculum that ingrains flaccid, monotonous education in a student’s mind also cements one’s image of the teacher. This is another divergence from common
preparatory avenues toward other occupations. Future students of education—as also deemed “victims” by Postman and Weingartner (1969)—often enter their teacher preparation programs with closed minds. After years of being an “armchair expert” (Bruxvoort, 2005), preservice teachers assume they already possess the necessary traits to become professional educators. They are convinced—consciously or otherwise—that they have learned enough about how to teach through their K-12 classroom experiences, a process which Lortie (1975) describes as an “apprenticeship of observation” (see also Tabachnick, Zeichner, Densmore, Adler, & Egan, 1982).

A rare dynamic emerges in education classrooms, something quite foreign compared to mainstream instruction for most disciplines. As opposed to other future professionals, teacher candidates frequently begin their preservice education assuming they have little to learn (Book, Byers, & Freeman, 1983). Consequently, students of teaching have a skewed and strained relationship with their collegiate professors. Lortie (1975) contrasts the education student’s mindset toward instruction with that of students in other majors:

One thinks, for example, of the engineering student’s relationship to his professors. Given the complexity and low visibility of engineering tasks and specialties, it is an unusual student who rejects, or even screens, professorial dicta on the basis of personally formulated judgments about engineering practice. But education students have spent years assessing teachers and many enter training with strong perceptions based upon firm identifications. Students in education may classify education professors as new members of a category (teachers) with which they are already most familiar. (p. 66)

Future teachers have spent years evaluating their various instructors. Their assessment criteria rely on personal feelings, opinions, intuition, and imitation, as opposed to explicit, analytical, sound pedagogical principles (Lortie, 1975). When preservice teachers enter college, they simply continue their subjective appraisal. Teacher educators’ expertise and
research rarely receive serious consideration. Preservice teachers presume they have little or nothing to learn (Lanier & Little, 1986). This assumption fabricates a self-fulfilled prophecy. The reproach toward preservice education exists before, during, and after the experience. Most future and current teachers do not provide favorable reviews of their preservice preparation (Bureau of Educational Research, 1983; Eddy, 1969; Fuchs, 1969; Griffin & Hukill, 1983; Little, 1981; Lortie, 1975; Ryan, 1970).

Both teachers and the general public see teaching as a fairly intuitive undertaking that requires little, if any, serious study (Lanier & Little, 1986). The internal contempt accumulates upon society’s general disrespect for the teaching profession (Shulman, 1986b). Sadly, perhaps the most remembered quote about teaching is George Bernard Shaw’s quip, “He who can, does. He who cannot, teaches” (Andrews, 1993). Public opinion views teaching as easy, commonplace, and its education without merit (Duggan-Haas, 1998).

Like teaching, teacher preparation faces a disparaging bias unlike any other discipline. Teacher education is considered “easy to enter, intellectually weak, and possibly unnecessary” (Lanier & Little, 1986, p. 542). Many people—including preservice teachers—believe no necessary concepts or skills must be learned (Munby, Russell, & Martin, 2001). Teachers are not viewed “as possessing a unique body of professional knowledge and expertise” (Feiman-Nemser & Floden, 1986, p. 512). In short, anyone can teach. Some have a natural flair or style that makes it easy for them and their students. “Good” teachers just have the right personality. Maybe they were born with it. This myth is disseminated by the assortment of excellent, mediocre, and paltry educators emerging from teacher preparation institutions. Social suppositions play a critical role in present policy decisions, just as they
have impacted the entire history of organized teacher education. Such idiosyncrasies must be considered when examining the preparation of teachers.

The History of Teacher Education

When reviewing the past, one frequently reverts to the practice of pining for the “good old days.” The same can happen for education. In truth, however, no “Golden Age” of teaching or teacher education has ever existed (Newman, 1990). Better days, some argue, would have yielded schools flourishing in democracy and innovation (Goodlad, 1984; Goodlad & Anderson, 1959; Goodlad & Klein, 1974). Nearly two centuries of formal teacher education have featured societal crosscurrents of high demand, low esteem, brisk criticism, and hasty reform. Goodlad (1990c) describes teacher preparation’s history as “an extraordinarily complex and cluttered landscape” (p. 107). In summarizing the teacher education setting, Goodlad calls attention to repetitive reform attempts. Efforts were bogged down in ineffectiveness due to ignorance of the complexity. Furthermore, most examinations and recommendations focus on pieces of the puzzle. The atomistic approach readily abides by the “lose the forest through the trees” mantra. Through piecemeal methods, reform efforts often function under segregation. Teacher education, school policy, and district change occur in separate, futile systems. Combining these challenges with the unique nature of teacher education provides further enlightenment about the field’s enduring trials.

Some enmesh the status and struggles of teacher education with those of women’s history (Goodlad, Soder, & Sirotnik, 1990; Mattingly, 1975). Biklen (1983), Hall (1982), Lightfoot (1983), and Nelson (1983) have all argued that the devaluation of teachers is due to the second-class status of women in the 19th century—a time when females became the standard schoolhouse instructor. Over one hundred years later, women remain the sizeable
majority of teachers, accounting for 83% of elementary teachers, 49% of secondary teachers, and 68% of all teachers (Feistritzer, 1983). Teaching as “women’s work” suffers from multiple prejudices. Ironically, the typecast woman had been a primary espousal for their initial employment as teachers. The stereotyped image of females’ gentle and frail natures became the very strengths needed to nurture America’s children (Lightfoot, 1978, 1983).

Nevertheless, teaching still suffers as a “victim of neglect and faulty diagnoses” (Goodlad, 1990c, p. xii) apart from women’s advances in equality. In fact, the broken glass ceiling affords women opportunities to pursue a variety of careers beyond traditional roles in education and nursing (Sedlak & Schlossman, 1986; Vance & Schlechty, 1982; Weaver, 1979). This progress has contributed to education’s “‘brain drain’ of bright, career-oriented students” (Newman, 1990, p. 65), regardless of gender. Indeed, teaching is viewed as “ordinary work” for both “ordinary” men and women (Feiman-Nemser & Floden, 1986). Most citizens will not deny the importance and goodness of teaching. Teaching is a noble profession—but for somebody else (Goodlad, 1990c).

Leaving the discussion of gender issues to others, this chapter will focus its review on universal issues facing teacher education. It does not suppose to divulge the entire landscape of teacher preparation. Rather, the intention is to provide clarity by recounting motivations and mechanisms behind the history of teacher education. Doing so will avoid the piecemeal approach denounced by Goodlad and others (Lanier & Little, 1986; Newman, 1990). To supplement the historical analysis with perspective and continuity, the following pages include elaboration of ongoing debates among educational leaders about what necessitates teacher education. This examination enhances study of the causes and effects of change.
Furthermore, it provides opportunities for reflection on the current state of education, another forthcoming topic of discussion. But first, the history.

**Normal Schools**

Formal teacher education is a fairly recent endeavor, especially with respect to millennia of civilization. Even the first two hundred years of America’s history is void of any widespread preparation of teachers (Lortie, 1975). During colonial times, no unified system of standardized qualification measures existed. The population of teachers, therefore, contained an array of expertise and experience. This included some with preeminent collegiate degrees, while others had little or no formal schooling at all (Cremin, 1970). Local school boards consisting of ministers, doctors, and other respected citizens granted teaching licensure (Lortie, 1975). Criteria for qualification were mostly subjective and emphasized moral responsibility, subject matter knowledge, and classroom control (Bruxvoort, 2005).

America’s schools swelled alongside the emerging Industrial Revolution in the early 1800s (Harper, 1939). Education became the avenue toward two important ends: gaining wealth and solidifying a young nation’s identity. Schooling was the means to form resilient industry, business, and government. Statesmen and educators alike contended that lasting success of the republic depended on its citizens being educated from childhood. Perhaps Daniel Webster (1782-1852) most clearly articulates the purveying view of that time: “On the diffusion of education among the people rests the preservation and perpetuation of our free institutions” (cited in Harper, 1939, p. 11). The nation’s rapid expansion in geography and population intensified the need for institutional education (Borrowman, 1956). Thus, the common school—also called the free or public school—took shape and hold of the American landscape.
During the first quarter of the 1800s, common schools educated more than 75% of American children (Harper, 1939). The quality of these schools depended mostly on the quality of their teachers. Upon recognizing this correlation, education leaders, government officials, and citizens called for assurance of quality teachers. Communities could no longer rely on willing individuals of varied education and abilities to teach children. The common school’s rapid propagation across the American landscape required a consistent, standardized level of teaching excellence. A formal system was necessary to adequately educate and ensure capable teachers.

Prior to this time, various institutions had housed teacher education, mostly in northeast America (Altenbaugh & Underwood, 1990; Borrowman, 1956). For well over a century, private academies taught individuals preparing for law, medicine, or the ministry. Some of these students would pursue teaching. An assortment of small private colleges even featured specific programs for teacher education. However, enrollments consisted of only those who could afford such classical training. Everyone else—the vast majority of citizens—missed out on quality secondary and post-secondary education. “The system throughout [sic] was education for the classes and not for the masses” (Harper, 1939, p. 12; emphasis added). General education for the democratic public arrived in the form of the common school system for children. For teachers, such a system began in the institution known as “normal schools.”

The birth of the normal school took place during a “renaissance” of sorts in pre-Civil War New England. Social and literature icons like Emerson and Thoreau criticized the surrounding materialistic, anti-intellectual, pragmatic society, and appealed to their fellow countrymen for equality, individualism, and progress (Borrowman, 1956). More schools
required more teachers. Academies and private universities did not produce the necessary numbers of educators. A new institutional organism had to arise along with common schools to shoulder the load. The formation of a public school system required efforts by government and political leaders such as Horace Mann, Daniel Webster, John Quincy Adams, and Charles Stowe, husband of Harriet Beecher Stowe (Borrowman, 1965; Harper, 1939). These same statesmen also campaigned for the creation of normal schools for teachers. This latter agenda was not initially supported by a majority of New Englanders. Normal school advocates, though, believed free education to be a guiding instrument in social policy (Borrowman, 1965). Quality schools required quality teachers. Horace Mann and others frequently referred to successes of state-sponsored teacher training in European nations like France, Holland, and Prussia (Altenbaugh & Underwood, 1990; Harper, 1939). Historically, the term “normal school” comes from a translation of the French école normale. The École Normale Supérieure (“Normal Superior School”) began in Paris in 1794, founded on principles displayed in German institutions. The name communicates the intention for the “normal school” to become a model for other teacher training institutions that followed (Britannica, 2006).

In America, teacher education struggled under private academia and inadequate “nontechnical” education. The call was for institutions that would provide specific training for teachers. Normal school proponents argued their cause at regular public addresses. The mission became one satiated of nobility, patriotism, and religious devotion, as typified by Horace Mann’s own words spoken in 1846:

I believe Normal Schools to be a new instrumentality in the advancement of the race. I believe that, without them, Free Schools themselves would be shorn of their strength and their healing power and would at length become mere charity schools and thus
die out in fact and in form. Neither the art of printing, nor the trial by jury, nor a free press, nor free suffrage, can long exist, to any beneficial and salutary purpose, without schools for the training of teachers; for, if the character and qualifications of teachers be allowed to degenerate, the Free Schools will become pauper schools, and the pauper schools will produce pauper souls, and the free press will become a false and licentious press, and ignorant voters will become venal voters, and through the medium and guise of republican forms, and oligarchy of profligate and flagitious men will govern the land; nay, the universal diffusion and ultimate triumph of all-glorious Christianity itself must await the time when knowledge shall be diffused among men through the instrumentality of good schools. *Coiled up in this institution, as in a spring, there is a vigor whose uncoiling may wheel the spheres.* (cited in Harper, 1939, p. 21; emphases in original)

Mann and his contemporaries faced an uphill battle to firmly establish a publicly-funded normal school system. Even a majority of teachers resisted and refused to support the notion (Harper, 1939).

Ultimately, immediate need overcame political opposition and public indifference. The tide turned in favor of founding institutions for teacher education. Assisting this shift in support was the creation of state boards of education that made decisions on funding and standardization (Newman, 1990; Sarason, Davidson, & Blatt, 1986). By no means was the initial transition definite or certain. But the seeds were planted. If for no other purpose, the public recognized that schools were destined to fail without enough educated teachers. The normal school system served the purpose of efficiently churning out trained teachers. This product was in high demand. Normal school graduates—or frequently dropouts, as will be noted shortly—could quickly fill the pressing need in the proliferating common school system. If not for the most noble of purposes, normal schools functioned as a tool of practicality.

The first normal school officially opened its doors on July 3, 1839, in Lexington, Massachusetts (Borrowman, 1965; Harper, 1939). It was the first time a state-supported
school had the exclusive purpose of preparing teachers. The inaugural class of education students had the diminutive enrollment of only three young women. Such were the meager beginnings of the normal school system. Nevertheless, growth soon arrived in multiple forms.

Within the next few decades, dozens of normal schools opened throughout New England. By the time of the post-Civil War Reconstruction Era, normal schools were the staple of American teacher preparation. The westward expansion grew exponentially with the onset of the railroad, telegraph, and agricultural industry (Harper, 1939). Normal schools appeared as a part of this expansion. “In this period the state normal school became a fixture in the educational scheme of practically every western state” (Harper, 1939, p. 86). Altenbaugh and Underwood (1990) provide numerical evidence of this amplification. Whereas only 11 normal schools existed in 1860, that number grew to 166 by 1898. Along with institutional expansion came the escalation of enrollment, from 10,000 preservice teachers in 1870 to 70,000 in 1900. Despite this sevenfold swell, normal school graduates often did not constitute the majority of public school teachers (Tyack, 1967). Those with no formal training still acquired positions, if not advancing the field, then at least fulfilling a need.

Growth also occurred with respect to institutional requirements, one method to address the varying credentials of schoolteachers. In the modest early years, the duration of the normal school program was typically one year at best. Some sequences consisted of a mere handful of months. This “inoculation” of sorts was not ideal, but necessary in the beginning. The short course load resulted in a fast track to get as many teachers as possible into hungry common schools nationwide. In fact, many normal school students never
completed the entire program. Yet even dropouts could secure teaching positions during this era before standardized state certification. “The fact was that teaching jobs at $30 a month could be had by those of little training and indeed did not invite a prolonged stay in a normal school” (Harper, 1939, p. 34). Eventually, normal schools raised their curricular standards, increasing the length of programs from one year to two over the course of a few decades. Replacing local school board authority, state certification standards assisted the increase in expectations. To become credentialed, teachers now had to complete approved coursework beyond the high school level (Lortie, 1975). The normal school’s typical two-year sequence expanded to four in some places, and “introduced college preparatory work and opened the door to the training of teachers for the high schools” (Altenbaugh & Underwood, 1990, p. 136). This latter addition—another form of expansion—was a topic of some contention among those who viewed the normal school’s purpose as exclusively training elementary teachers. As shall be discussed in more depth shortly, the topic of purpose—and therefore curriculum—in teacher education institutions is the linchpin of nearly all debates regarding preservice preparation.

Perhaps the greatest source of expansion was due to the results normal schools produced. Harper (1939) cites two aspects that produced positive feedback:

The success of the normal-school movement was due to the inherent reasonableness of the idea that teachers need specific training in an institution devoted entirely to that end. Secondly, the normals became established in public favor because it was abundantly evident that former students and graduates of these schools were better teachers than those educated elsewhere. (p. 97)

The latter effect of normal schools—that of superior teachers—relies on a much further investigation into criteria used to measure excellence. The assessment tools used during this time were not clarified, though national education leaders such as Richard Edwards—former
Massachusetts normal school principal and president of Illinois Normal University—shared his judgment to an 1876 gathering of the National Educational Association: “[T]he young men and women, educated or partly educated in our normal schools, have on the whole proved themselves more efficient as instructors of the young than the average of their compeers” (cited in Harper, 1939, p. 98). These results—whether perceived, genuine, or both—endowed normal schools “a secure place in public confidence and approval” by the latter decades of the 19th century (Harper, 1939).

The professed “reasonableness” of specific teacher preparation was not always so apparent. Public opinion did not see the need or value of formally preparing teachers. As an institutional entity, the normal school was an argument for the necessary and unique education of teachers. “The normals were moving along in these two decades [1840-1860] in a crusade to produce a profession of teaching” (Harper, 1939, p. 39; emphasis in original). Supporters of normal schools viewed their institutions as the means for helping teaching reach the status of a professional. “The word ‘professional’ became the symbol of a new gospel, and the need to make of teaching a ‘true profession’ was invariably cited as one of the prime reasons for the normal school movement” (Borrowman, 1956, p. 59). The very identity of the early normal school relied on its monopoly on excellent teacher preparation. Public favor grew upon evidence of normal school graduates’ “superb craftsmanship in classroom management” (Borrowman, 1965, p. 19). Common schools and communities preferred teachers with normal school diplomas. These teachers had the reputable ability to successfully run a classroom, if nothing else. Normal school graduates revealed themselves to be better equipped at dealing with classroom management, discipline, and procedures (Altenbaugh & Underwood, 1990). For many schools and communities, such technical
advantages alone were enough to support “buying” more of the normal schools’ products. Moreover, normal schools used the positive response as reinforcement of their original intent to train teachers. From the earliest founders of the normal school, the consensus was that no other objective should sidetrack this exclusive undertaking of teacher preparation.

Normal schools emphasized professionalism to the point where teacher preparation almost became a perfunctory, vocational endeavor. The rationale for this approach was to avoid losing preservice teachers among the ambiguity of academia (Borrowman, 1956). Any content learned must connect directly to classroom teaching. Technical skills always eclipsed academic enlightenment.

[It was never a question of giving or of not giving the professional subjects, but always of how much academic material would suffice to supplement the defective preparation with which most students came equipped. All subjects were presented or reviewed from the standpoint of their most effective presentation to a class, and the practical usages of instruction received heavy emphasis. (Learned, Bagley, McMurry, Dearborn, & Strayer, 1920; cited in Borrowman, 1965, p. 186)

The adherence to pragmatism drew the ire of larger universities and assorted educational leaders, including some from normal school institutions. They argued that teachers need knowledge in addition to skills. William Phelps, first principal of the Trenton (NJ) State Normal School in the 1860s, became known for inquiring his contemporaries through the following slogan: “How are you to teach them how to teach that of which they know nothing?” (cited in Borrowman, 1956, p. 45).

Similar concern appeared in the prototypical European schools during the time when Horace Mann and his contemporaries were initially drafting American normal schools. German educators, for example, anticipated the need for teachers to acquire knowledge beyond the intended classroom level. “The teacher of the future must be taught to think and
not trained as a machine” (Kandel, 1910, p. 11). Rather than specific techniques, teachers must learn content knowledge as well as general principles of education and learning (Borrowman, 1956). This discussion arose at the very onset of normal schools and simmered throughout the years. Many education leaders struggled to articulate the issue even among themselves. Fervent normal school advocate Richard Edwards wrestles with this dichotomy in his 1865 address to the National Teachers’ Association:

In an ordinary school, the treatise on arithmetic is put into the hands of the student in order that he may learn arithmetic; in the Normal School, the same book is used to enable him to learn how to teach arithmetic. In the ordinary school, the youth reads his Cicero with the purpose of learning the structure, vocabulary, and power of the Latin language; the normal student pores over the same author that he may adjust in his mind a method by which he may most successfully teach others these things. Both use the same materials, acquire, to some extent, the same knowledge, but aiming all the while at different ends. Of course it is clear that one of these objects must presuppose the accomplishment of the other. The proper work of the Normal School can not be performed unless the mastery of the subjects has first been obtained. (cited in Borrowman, 1965, p. 76; emphases in original)

Again, the complex relationship arises between concept understanding and ability to teach. The effective teacher holds both attributes. In the realm of teacher preparation, one aspect does not function properly without the other. Which one deserves more attention? The quandary festers.

Normal school curricula did vary from campus to campus (Altenbaugh & Underwood, 1990). Nevertheless, the majority of institutes concentrated on technical skills. A key component of this preparation came through practice teaching. The idea of practice teaching and a training school began with the inception of the American normal school. Quoting Altho Page, principal of the Albany State School in the 1840s, Harper (1939) writes,

The purpose was “to afford each Normal pupil an opportunity of practicing the methods of instruction and discipline inculcated at the Normal School, as well as to
ascertain his aptness to teach and discharge the various other duties pertaining to the teacher’s responsible office.” (p. 46)

Normal schools often housed their own “training” or “practice” schools on campus, complete with pupils of all age groups and full-time teachers. These classrooms also functioned as models for preservice students to observe. Such on-site experiences replaced previous attempts of having normal school classes role-play teacher and adolescent students in assorted situations (Borrowman, 1956). Once more, the emphasis had shifted further to direct classroom connection and technical practice. In the same 1865 address to the National Teachers’ Association, Edwards describes the purpose and role of the practice school:

The school for practice is unquestionably essential to the complete idea of a Normal School. When the young practitioner is dealing with children, he encounters the reality of his work. The actual difficulties of his employment are before him. There is no make-believe. He is never in doubt as to whether his methods are such as to instruct and interest children, for the children are there, and he can see for himself, and all others can do the same, whether they are instructed and interested or not. Every question he asks, every suggestion he makes, is tested on the spot by the proper and natural test. (cited in Borrowman, 1965, p. 81)

Edwards’ words reaffirm the normal school sentiment for pragmatic preparation. Authentic classroom experience, immediate feedback, candid trial-and-error training became the combined impetus—the capstone for educating teachers.

Two movements had profound influence on normal schools’ approaches to teacher preparation. The Oswego method, or “Object Teaching,” originated from the mind of Edward Sheldon, head of the normal school in Oswego, New York, during the mid 1800s (Harper, 1939). Sheldon framed his Oswego method of teaching teachers around the writings of Johann Pestalozzi (1746-1827) and the prototypical Prussian institutions. The emphasis was learning through authentic experiences.
Teaching in the Prussian schools was to be no longer a matter of assigning pages of printed material to be memorized, and then of holding the open book while the child repeated the lesson. Pestalozzi described the process of teaching as directing the child in the unfolding of his latent powers, and emphasized the harmonious development of the individual’s faculties into a complete personality. (Harper, 1939, p. 18)

Textbooks were often abandoned in favor of direct classroom encounters in practice or training schools. Though classroom training had occurred previously, the Oswego method created an organized approach: “there was a continuing emphasis on the need to systematize the rules and thus make teaching ‘scientific’” (Borrowman, 1956, p. 115). This technical approach gained the favor of numerous educators and the Oswego method became a model copied by many normal schools. However, the emphasis on systematic skills came at the expense of new teachers’ conceptual understanding. “The work at Oswego was so well organized that the students were quickly trained in the technic, though [sic] often emerging with hazy ideas concerning the fundamental principles” (Harper, 1939, p. 123). In some respects, the second major movement during the normal school era arose as a reaction to the Oswego method.

The Herbartian movement derives its name from German educator and philosopher Johann Herbart (1776-1841), who argued that education relies on experience. “[Herbartianism] preached the doctrine of interest, the organization of subject matter around fundamental meanings, and the inclusion of vital materials in the curriculum, as opposed to textbook slavery and facts taught with dull monotony” (Harper, 1939, p. 125). At first glance, one might assume the Herbartian movement was no different than that which came from Oswego. The difference, though, lies in Herbartianism’s emphasis on elementary ideas. Herbart himself claimed that learning arrives through motivation by connecting new ideas to
students’ interests (Clark, 1999). As with the Oswego method, the Herbartian movement worked to define a science of education, a pedagogy. However, the latter “did focus attention on the possibility of a general method of teaching that was based upon a careful analysis of the act of thinking” (Harper, 1939, p. 126). These efforts remained mostly through deductive thought, though, with little investigation to support these claims (Borrowman, 1956). Educators struggled to defend their methods based on any empirical evidence. Others such as John Dewey attempted to articulate the difference between a technique-based “apprenticeship” and the preferred “professional laboratory activities” which incorporated conceptual understanding along with skill acquisition (1904/1965):

> On one hand, we may carry on the practical work with the object of giving teachers in training working command of the necessary tools of their profession; control of the technique of class instruction and management; skill and proficiency in the work of teaching. With this aim in view, practice work is, as far as it goes, of the nature of apprenticeship. On the other hand, we may propose to use practice work as an instrument in making real and vital theoretical instruction; the knowledge of subject-matter and of principles of education. This is the laboratory point of view. (p. 142)

Dewey’s words describe the delicate balance faced by educators when teaching teachers. A fine line exists between technical training and experiencing theory in action. Herbartians attempted to assimilate theoretical understanding—albeit an incomplete one—into teacher preparation. Both the Oswego and Herbartian movements steered normal schools for multiple decades, mostly in stressing practice experiences and classroom connections.

Although technical skills took precedence, normal schools did include content learning in their curriculum. The very first schools featured core subjects—reading, writing, arithmetic, geography, philosophy, and reading of Biblical scriptures—in addition to methods of teaching. The content was equivalent to that taught in district schools. However, normal schools prided themselves on teacher preparation and pragmatism. “Because the
academies and colleges looked down with contempt on the normals from the aloofness of their classical curriculums, the normals took fierce joy in glorifying the branches of common everyday learning” (Harper, 1939, p. 30).

The normal school began with an unyielding mission: to teach teachers. This purpose was accepted as truth and preached to the masses:

In these schools the whole animus of both teacher and pupil is the idea of future teaching. Every plan is made to conform to it. Every measure proposed is tried by this as a test. There is no other aim or purpose to claim any share of the mental energy of either. It is the Alpha and Omega of schemes of study and modes of thought. (Edwards, 1865, p. 77; cited in Borrowman, 1965)

Normal schools often contained similar declarations of conviction in their mission statements. Some normal schools required registering students to sign a pledge announcing intent to enroll for the sole purpose of becoming a teacher (Learned et al., 1920/1965). “The idea that a teacher education institution must have this singleness of purpose, that the demands of the professional task must dictate the whole preservice program, was central to the very concept of the normal school” (Borrowman, 1956, p. 56). But singularity in purpose did not last forever. For this and other reasons, the American normal school era began its twilight at the dawn of the 20th century.

Despite the pragmatic goal of remaining restricted to teacher preparation, normal schools slowly found themselves teaching more than just future educators. As alluded to above, a concerning issue during the early years was the high number of normal school dropouts. School recruitment and state requirements created standards to address this problem. In the later years of normal schools, the issue was not dropout rates, but the vast number of graduates who never became teachers. Normal schools were unable to enforce the required commitment their students made to teaching in public schools. Even as normal
schools grew across the nation, their initial, exclusive purpose of teacher education waned. Students demanded and, in some cases, required additional instruction with respect to general academic courses. “Nor could the normal schools completely resist the temptation to attract nonprofessional students by stressing the useful as well as the liberal value of their courses” (Borrowman, 1956, p. 76). To some extent, growth in enrollment and finances deemed that normal schools broaden their horizons. By the end of the 19th century, many of these schools eventually softened their rhetoric about teacher preparation exclusivity. They began to openly invite the enrollment of students who were not particularly interested in becoming teachers (Learned et al., 1920/1965). In many normal schools, a majority of students enrolled did not intend to teach permanently or at all. They could use their diploma as an avenue to occupations other than teaching (Altenbaugh & Underwood, 1990; Levin, 1990).

The splintering of the normal school design into both professional and academic preparation could have been its greatest downfall. The temptation was too great. Normal schools found the money and prestige as motivation to diversify. Communities and state legislatures provided additional pressure to expand programs (Altenbaugh & Underwood, 1990). Such external forces strained those who fought for the original intent of normal schools. The following statements from normal school supporters Learned et al. (1920/1965) convey their embattled position:

- Every normal school student should feel behind him a full tide of pressure from every quarter urging him to teach and to do nothing else, and he should contribute the impetus of his own clear decision to the general impulse. (p. 204)

- The normal school that is true to itself finds it impossible to be a college. (p. 205)

- Its sole aim being to train teachers, every item of its organization should contribute either to the final excellence of its product, or to the creation and maintenance of conditions in its region that will make its product most successful. Irrelevant work
that can be done elsewhere should be discontinued as soon as possible. . . divisions of aim, however attractive, should be avoided. The school should do one thing and do it mightily. (p. 206)

Unfortunately for Learned and his contemporaries, they soon found themselves in the minority.

Internal strain emerged within institutions. Faculty, administrators, voters, and students alike found themselves at a crossroads. As history reveals, the diversification movement was victorious (Borrowman, 1956). Normal schools indeed partitioned their programs. In some institutions, the transition from single purpose to multiple options occurred as early as 1850. Teacher education became simply one aspect of the organization. Other normal schools remained fixed in their original purpose of training teachers. Over the next several decades, though, most expanded their programs and became more inviting about their diverse offerings. At the time, Learned and his colleagues (1920/1965) labeled this weakening of the original intent as “positively disastrous.” Indeed, their prognostication on the fate of normal schools was correct. By the 1940s, the initial incarnation of a publicly funded, exclusive institute for teacher preparation had become obsolete (Altenbaugh & Underwood, 1990; Goodlad, 1990c).

Contrary to Learned et al. (1920/1965), some have argued normal schools were able to last as long as they did because of their diversification. “The acceptance and success of normal schools had little to do with their presumed purpose of teacher training. Local communities supported and promoted them because they were viewed as secondary schools” (Altenbaugh & Underwood, 1990, p. 141). This is especially true for American normal schools in the Midwest and West. These schools never felt the pressure to focus solely on teacher preparation. On the contrary, their constituents looked upon normal schools as
multipurpose institutions. Beginning in the later decades of the 1800s and the early decades of the 1900s, normal schools opened their doors to students of varied interests. Students attended the normal school to acquire general academic preparation. In terms of curriculum and function, the schools themselves resembled private academies, public high schools or—by the end of the 19th century—general colleges (Herbst, 1980). Whether for good or bad, whether favored or opposed, whether intentional or fortuitous, normal schools forsook their original intention as teacher preparation facilities. Along with this change in the normal school—which Altenbaugh and Underwood (1990) designate “an erosion of its founding mission”—came a loss of its unique identity.

Normal schools’ identity also vanished as universities absorbed them into their statewide systems. The imminent university expansion influenced normal schools even before widespread assimilation. Many normal schools began to follow the university model (Altenbaugh & Underwood, 1990). This imitation included diversified programs, non-education related training, and a greater emphasis on academic and liberal education. Many students began to view normal schools as a stepping-stone toward university enrollment (Learned et al., 1920/1965). This evolution occurred to the detriment of teacher preparation.

In their early exclusive form, normal schools meshed well with the common schools. Graduates fit the needs and expectations of communities for public school teachers. A partnership formed between the common and normal institutional levels. Universities and liberal colleges did not have the same favorable relationship, mostly due to a gap in priorities (Harper, 1939). Common schools required teachers highly trained in management and technique, which was normal schools’ specialty. Universities, private academies, and liberal colleges preferred its graduates have a firm foundation in academic understanding and
appreciation. This background did not translate as well into the elementary or secondary classroom.

The disagreement in educational objectives is one reason why normal schools and universities initially existed in disharmony. As has been noted and will be discussed further, the normal school focused on training preservice teachers the techniques to manage a classroom (Altenbaugh & Underwood, 1990; Borrowman, 1956, 1965; Harper, 1939). “Train” is the operative word, as normal schools emphasized procedural skills practiced through a hegemonic, mechanical framework of behavioral psychology (Feiman-Nemser & Floden, 1986). Emphasizing the teacher’s role is indeed an important component. Yet at the time, teacher educators possessed limited research into effective teaching knowledge. In its juvenile decades, organized teacher education was hopeful but unsophisticated. The extent to which normal schools truly prepared teachers to handle the complex interactions and decision-making in the classroom is questionable. Borrowman (1956) concludes, “both the faith and the early program of teacher education were naïve” (p. 60).

In addition to this frail foundation, normal schools found themselves as the object of contempt by universities. Normal schools’ clichéd use of the word “professional” created disdain among academic circles. Although tension had always existed, now the derision became more widespread. Communities that had once supported normal schools shifted their allegiance to the more powerful and prestigious universities. Normal schools faced oblivion. In an effort to gain further acceptance and attendance, normal schools relaxed their strident exclusivity to teacher training. The formerly focused aim of teacher preparation blurred to a hazy spectrum of academic pursuits. For a time, normal schools became miniature, cheaper alternatives to the university system. Upon analyzing course programs, Johnson (1989)
concludes that “By 1900 . . . concentration on academic training was the norm, not the exception, among American normal schools” (p. 16; cited in Altenbaugh & Underwood, 1990, p. 150). Despite being at odds early on, normal schools eventually lost out to the academic approach of universities. In many states, the university expanded and engulfed normal schools into its larger structure. The assimilation of normal schools ultimately occurred at both an ideological and infrastructure level.

**Teachers Colleges**

The transition from normal school to university was not immediate. Nor was it straightforward or consistent nationwide. While teacher preparation moved along its educational “rite of passage” from unknown, invalid entity to publicly recognized institutional fixture (Goodlad, 1990c), it had a brief stint in the spotlight of teachers colleges. The teachers college arena had the shortest lifespan of any institutional framework for teacher preparation. This period began in Depression Era America—during the demise of normal schools—but quickly faded to obscurity by the early 1970s. At its peak pre-World War II, the teachers college system supplied America with slightly over half of all public school teachers. This occurred at a time when universities and state colleges outnumbered teachers colleges by a factor of two to one (Harper, 1939). Just like the normal school, the dominance of the single-purpose teachers college did not last. As early as the 1960s, many teachers colleges had become “multipurpose state colleges or state universities, which granted liberal arts and other degrees as well as education degrees” (Altenbaugh & Underwood, 1990, p. 150). By the 1970s, nearly every school of education functioned within a state college or university system (Goodlad, 1990c).
Even in their fleeting existence, teachers colleges did offer noteworthy contributions to teacher education. During the 1920s in the Midwest, normal schools first began their evolution into teachers colleges. Along with this change came the solidification of the four-year program as a standard component of teacher education (Altenbaugh & Underwood, 1990). These institutions could now award four-year diplomas with names such as Bachelor of Pedagogy or the professionally partial Bachelor of Education. Some teachers colleges even began providing graduate programs and conferring master- and doctorate-level degrees (Borrowman, 1965; Harper, 1939).

Part of the teachers college growth was a reaction to the continuing expansion of American public schools and, in particular, the developing high school system (Harper, 1939). Certification laws demanded higher standards and more meticulous hiring practices (Borrowman, 1956). Curriculum had to advance beyond professional techniques to meet the needs of future high school teachers. Still, many former normal schools—especially those in the East—resisted diverging from their initial intensive teacher programs. Most teachers colleges, though, featured a wider range of elective courses and differentiated curriculum. All the while, these institutions clung to the pragmatic paradigm (Harper, 1939). Even the prototypical Teachers College at Columbia University found itself mired in internal debate among academic and vocational camps (Russell, 1924/1965). Despite this turmoil, Teachers College at Columbia, founded in 1887, was the embodiment of synthesizing liberal and technical education for teachers (Borrowman, 1956). In the decades to come, most institutes for teacher preparation would follow Columbia’s pioneering example. “To design a professional sequence adequate to both [vocational and academic] traditions was the central concern of the schools of education” (Borrowman, 1956, p. 155).
For many former normal schools, the teachers college designation was also a reaction to university-initiated accreditation entities such as the North Central Association (NCA) of Colleges and Secondary Schools. Starting in 1896, the NCA formulated requirements of high school teachers, such as the standard that all high school teachers have college degrees (Harper, 1939). The National Council for Accreditation of Teacher Education (NCATE), founded in 1954, was another external force guiding teacher preparation institutions (Altenbaugh & Underwood, 1990; Hendrick, 1990). Schools had to continuously revisit and restructure their programs to avoid losing accreditation. Maintaining solvency required education schools to balance the complex pressures from NCA/NCATE standards, state officials making funding decisions, and upholding ample enrollment and attracting qualified students. It was a challenge not too many could survive as solitary institutes.

Despite minor modifications, the normal school/teachers college transition was essentially an image makeover. Much of the change came as defensive reactions to pressing needs and growing attention to the teaching field. As early as the 1880s, universities and large colleges grew more interested in adding teacher education to their academic repertoire (Harper, 1939). Rewording “normal school” to “teachers college” added sophistication and legitimacy to the institution and its endeavor for the profession. Organizations such as the National Education Association had recognized the value of effectively branding teacher preparation and supported the title alteration (Harper, 1939).

In the end, though, teachers colleges succumbed to similar stresses and neglect as did their previous normal schools incarnations. The schools felt compelled to copy academic pursuits of the universities. Teachers colleges continued diversification of institutional objectives and programs, diluting the initial intent of teacher education. Moreover, this
action undermined teachers colleges’ status in the eyes of the public. Many states saw their teachers colleges as redundant institutions siphoning funds away from larger, more venerated universities. Starvation of finances followed this tainted image. More money went to the larger institutions. In spite of some contributions to teacher preparation, teachers colleges followed normal schools’ earlier demise. The age of teacher education as a single entity had vanished. By the 1970s, larger state colleges and universities had taken command. Teacher preparation was relegated to “cog” status among higher academia’s mighty structure.

**Universities**

By 1900, universities had begun integrating academic, liberal education with professional training used in normal schools (Borrowman, 1965). At the time, however, most university education professors preferred preservice students who had already completed all general education requirements. “Many college professors of pedagogy also insisted that professional instruction should follow the completion of most of general education. This insistence was usually based on the assumption that such matured scholarship was needed if one were to profit from professional study” (Borrowman, 1956, p. 91).

The establishment of university schools of education gave many educators a hope that their profession would reach the same status of other esteemed fields such as law or medicine. However, most universities bypassed the unglamorous realm of teaching and focused instead on graduate level administrative training for those elite few who would manage schools (Powell, 1976). “Women and less able men, who would necessarily comprise the massive teaching force, could continue to receive a meager and technical preparation” (Lanier & Little, 1986, p. 533). The professional, practical concentration so
highly lauded by normal schools had become an ugly albatross in the eyes of university academics. Even Abraham Flexner, who had turned his attention to teacher education following his monumental service to medical education, originally sought support for teacher preparation. Yet his own backing waned as he observed the overt technical training at the expense of intellectual endeavors (Powell, 1980).

Such was the case with university faculty both within and outside schools of education. For many professors, the idea that teaching contained particular concepts and skills to be formally learned defied their previous experiences as university educators. Goodlad (1990c) describes the effects of teacher education’s intrusion into the academic setting:

[S]cholars in the arts and sciences who taught without benefit of training perceived the emergence of pedagogical science as a kind of insult—a put-down of their self-acquired art. College and university teachers, if not born with the requisite skills, acquired them through rigorous inquiry into their disciplines. Their studies did not and needed not include pedagogy. Suggestions to the contrary were an affront. (p. 74)

These “educators” had developed their craft through decades of practice. They did not perceive any need for formal teacher education. It was something that merely happened through experience. A common sentiment asked the question, “Why waste time on teaching how to teach?” And so many did not. Borrowman (1965) notes how university professors opposed the notion of giving time to teach the “science” of teaching. Certainly, teacher education entered the university system in a cloud of skepticism: “Teaching is an art. Therefore there is indeed no science of education. But what there is, is the world of science furnishing material for the educator to study” (Royce, 1891/1965, p. 126).
Royce’s words indicate an alternative to teaching teachers: study them instead. This approach resonated with the research mindset valued by most university faculty. And it continues today:

Indeed, much of what goes on in these schools of education has little to do with teaching or preparing teachers for the lower schools. Professors study educational phenomena in the same way that colleagues in other departments and schools study biological, geological, architectural, and chemical phenomena. (Goodlad, 1990c, p. 75)

Goodlad reports that some universities, including many private institutions, have ceased any form of teacher preparation. Instead, their schools of education become “part research institute and part graduate center of study for experienced teachers and school administrators” (1990c, p. 173). Present actions resemble similar attitudes first expressed a century ago in universities.

Impulsion towards research comes not only from its glorification in other university colleges, but also from the spurned status of education, the latter which Goodlad (1990c) claims suffers from “chronic prestige deprivation” (p. xiii). The humble history of teacher education does not entice professors’ attention. If they are to give any consideration, their interest arrives in the form of empirical research. Only from this slant will university professors touch the radioactive education element. Goodlad (1990b) summarizes the continuing condition on campus:

One needs to have only a modest acquaintance with higher education to be aware of the degree to which research dominates university life. The pecking order of major universities depends almost entirely on the size of their extramurally funded research budgets and the visibility of their faculty as evidenced by publications based on their research. Visibility built on research activity and publication in prestigious journals provides both career mobility and comforting assurance of being wanted. . . . Scholarly work provides a professor with airline tickets (accompanied by honoraria) to the rest of the world. A colleague may be recognized as a gifted teacher, but such a
reputation will not carry far beyond the local campus and certainly will not provide equal mobility and monetary rewards. (p. 23)

In mining prestige from education studies, professors ignore ample teaching opportunities and instead hunt for valued nuggets of research. This one-sided quest is essential to maintain their livelihood. For professors seeking tenure and promotion, a track record of research activity trumps any record (or lack thereof) of teaching effectiveness, professional activity, and institutional service (Hendrick, 1990). This same hierarchy has recently become more prominent in smaller universities and colleges (Burgess, 1990).

The research incentive occurs for individual professors as well as among the larger organizational echelon:

[T]he shocking reality is that many presidents of [universities] now preparing teachers measure their institutions’ “progress” by the degree to which they have distanced themselves from teacher education in evolving from normal school to teachers college to state college to state university. Instead of educating future teachers, many professors of education, especially in the most prestigious research universities, only conduct studies of them—if these professors are involved in teacher education at all. (Goodlad, 1990c, p. 46)

At both an institutional and individual level, education is valued only as a subject of study, not improvement of teaching itself. University and education leaders unabashedly advertise this stance. In fact, school of education deans have proudly acknowledged how their faculty are responsible for studying, not preparing teachers (Judge, 1982).

One must question the effects of championing research over actual education of teachers. Despite his aversion to rudimentary technical preparation of teachers, Flexner had openly conveyed anxiety toward not finding enough professors of medicine who could effectively teach in the schools he studied (1910). These concerns have come to fruition. At present, most medical school professors are giving increasing amounts of time to research
and grant work. This comes at the expense of actually teaching and preparing future doctors (Goodlad, 1990c). Indeed, the same dismal state spreads in schools of education:

The impact of this growing academic fashion on teacher education has been severe and is becoming more so. The impact in institutions already in or nearly in the circle of prestigious universities is clear: Teacher education not only ranks low among university priorities, it is marginal in the school or college of education. (Goodlad, 1990b, p. 25).

Here Goodlad is not lamenting the inclusion of academic components in preparing teachers. As the running discussion of curriculum has examined, academic learning is essential for completely educated teachers. Teacher educators’ emphasis on academia alone, though, is detrimental for these same preservice teachers.

One consequence of the priority shift is the erosion of a central purpose, occurring in major and regional universities as well as private colleges (Goodlad, 1990c). “Since coming to institutions of higher education, teacher education has operated on the assumption that it should remain an all-university responsibility” (Lanier & Little, 1986, p. 529). Put another way, no one wants to claim ownership. The push for research causes the mission to diverge even further. University professors have little time or attention to spare for the sole purpose of teaching teachers. As addressed above, professors’ recognition and advancement depend little on teacher preparation. Minute motivation exists to pursue excellence in teacher education.

An exemplar of the neglected condition of teacher preparation in universities is the absence of designated teacher educators. In universities then and now, most arts and science professors—those who teach much of the subject matter to future teachers—do not even consider themselves as “teacher educators” (Lanier & Little, 1986). Professors who teach educational foundations courses (psychology, sociology, philosophy, etc.) decline the title in
lieu of their primary discipline. The “teacher educator” label then shifts to those who teach methods courses. Yet even these professors frequently cite their subject area for identity, such as science educators or reading educators. Student teacher supervisors, on the other hand, may claim the designation of teacher educator. However, these faculty members are often not full-time staff and have little or no contact with preservice teachers until the student teaching semester. Borrowman (1965) observes, “In these institutions, the majority of faculty members have an interest in teacher education that is, at best, tangential to their most active concerns” (p. 39; emphasis added).

The decentralization of teacher education has several far-reaching effects. For one, students who enter teacher education in these diverse universities often do so with less than noble purposes. The choice in major may be their third or forth. Furthermore, teacher education may lose exemplary candidates. “In large multi-purpose colleges and universities, potential teachers are lured into other professions, and one senses that those who do become teachers are less motivated by altruism, less ‘called’ to serve than those prepared in single-purpose institutions” (Borrowman, 1965, p. 75). Whereas most students entered normal schools and teachers colleges with one goal in mind (in the early years, at least), majoring in education at a university simply becomes one of many choices while lingering over an academic smorgasbord.

The very identity of teacher education remains shattered among the university mosaic. Following their study of teacher preparation institutions in higher education, Clark and Marker (1975) conclude that “few organizations could survive, to say nothing of perform, with the bizarre disjunction between assigned functions, authority, and responsibility which exists in the institution of teacher education” (p. 75). A majority of

The starvation of attention and finances could be a direct cause of most education departments’ reticent pursuit of excellence in teacher education (Peseau, 1982). A sizeable portion of finances originates from the enrollment of students in teacher education. Therefore, schools of education undergo pressure to maintain substantial numbers of incoming students (Sykes, 1983). Standards drop in order to attract more students and more money. This perpetuates the diminished quality of candidates and perceptions of university professors and students: “Rather than forestall further slippage in the talent pool for teaching, such programs actually become part of the problem, serving as disincentives to bright students, who shun association with a major stigmatized as anti-intellectual” (Sykes, 1983, p. 90).

A final effect of university teacher preparation is the impact on K-12 schools. Collegiate schools of education have made their intentions clear: the further they are separated from K-12 systems, the higher their status in academia (Goodlad, 1990c; Judge, 1982). This widening gap, however, could have devastating effects on American education. Schools themselves do not provide extensive, organized assistance for new teachers (Fuchs, 1969; Little, 1981; Lortie, 1975; Zeichner, 1980, 1983). Responsibility for teacher preparation lies indefinite and unclaimed. To expand upon Clifford and Guthrie’s (1988) ominous analogy, public schools are left behind while universities voyage toward research
lands, islands where tempting songs erase memories of responsibility. As for these siren-beguiled universities, Gifford (1988) provides the following bleak verdict:

> Close scrutiny has rarely resulted in findings favorable to schools of education. More often than not, these reviews have found schools of education to be confused about their goals and objectives and unclear in their mission: driven too much by practical considerations and concerns, thus insensitive to the scholarly mission of the university; driven too much by scholarly considerations and concerns, thus insensitive to the problems that plague practitioners; too detached from the problems of schooling and too narrow in their intellectual pursuits to be relevant; too close to the problems of schooling and too diffuse in their intellectual outlook to be scholarly. (cited in Hendrick, 1990, p. 236)

Dissatisfaction continues regarding the preparation of America’s teachers. After nearly two centuries of institutionally based approaches, the nation has lately turned to alternative options for certification.

**Alternative Certification**

Although universities and colleges continue to graduate the majority of American teachers, other programs have gained popularity in recent years. “Alternative certification” is the common term applied to all of these non-traditional approaches (Tom, 1991). Even in its limited years of existence, alternative certification of teachers has become a contentious issue among universities and colleges, communities, schools, and legislatures. “No issue related to teacher preparation has generated more debate than the issue of the effectiveness of alternative route preparation programs” (Allen, 2003, p. 3).

Alternative education comes in many shapes and sizes. Programs range in scope from the national level (Teach for America, for example) to city districts such as New York’s Teaching Fellows Program and the Los Angeles Teacher Trainee Program (Windschitl, 2005). State legislatures also weigh in on creating alternative credential routes for teachers. Usually, the statewide approach is to minimize or eliminate requirements. Since 1985, New
Jersey schools have been able to hire individuals with no formal teaching preparation, but rather who have a bachelor’s degree in a content area and simply pass a test in the same subject (Newman, 1990). Idaho awards teaching certificates to anyone who can pass online exams managed by the American Board for Certification of Teacher Excellence (U.S. Department of Education, 2003; Windschitl, 2005). Other states have set maximum limits for education courses (Newman, 1990) or dismiss the need for teachers to have taken courses in curriculum study, teaching strategies, technology use, classroom management, or special education (Galley, 2004; Georgia Professional Standards Commission, 2004; Keller, 2004). Some states have proposed teacher licensure programs with no formal training whatsoever (Windschitl, 2005). Such omissions are obligatory for alternative programs that manufacture “teachers” at the lightning speed of a few weeks (Windschitl, 2005). Some alternative approaches have been described as “boot camp” teacher preparation, in which people move from entering the program to entering the classroom in eight weeks or less (Craven & Penick, 2001).

Science education has garnered particularly intense attention toward alternative certification, mostly because of the present void of qualified science teachers (Baron & Rusnak, 1990; Cavallo, Ferreira, & Roberts, 2005; Lerner & Zittleman, 2002; Newman, 1990; Weiss & Boyd, 1990). Windschitl (2005) notes at least two features that make science teaching susceptible to alternative programs. First, the current scientific and technological age bestows high esteem to scientists and individuals with scientific knowledge. Many assume that those who hold scientific understandings can easily pick up the nuances and skills needed to teach in a classroom. Moreover, such bright individuals are “smart enough” to acquire these abilities through “on-the-job training.” Again, the notion that content
knowledge yields effective teaching reappears among educators, citizens, and policymakers. The second reason Windschitl provides for science education’s alternative credential vulnerability is the field’s desperate need of teachers. A nationwide shortage of science teachers persists (NCMST, 2000; Olson, 2000). Teaching science, like teaching secondary math, requires an instructor with advanced expertise not found in any ordinary “unlicensed pedestrian.”

Those researching demographics of teacher candidates indicate that many who seek alternative certification are older and often in the middle of changing careers (Beach, Littleton, Larmer, & Calahan, 1991; Lerner & Zittleman, 2002; Resta, Huling, & Rainwater, 2001; Southern Regional Educational Board, 1988; Stoddart, 1993). Alternative certification has been one avenue leading to a higher population of minority teacher candidates (Allen, 2003). It is also an attempt to address the serious need for certified teachers in urban areas (Baron & Rusnak, 1990; Cavallo, Ferreira, & Roberts, 2005; Chen, Paige, & Bhattacharjee, 2004; Craven & Penick, 2001; Jorissen, 2002, 2003; Zumwalt, 1996).

Unfortunately, alternative programs typically have not fostered any results better than traditional certification programs from universities and colleges. “Overall the research provides limited support for the conclusion that there are indeed alternative programs that produce cohorts of teachers who are ultimately as effective as traditionally trained teachers” (Allen, 2003, p. 3). Comparison studies of retention rates among alternatively and traditionally credentialed teachers reveal mixed results. Some have found that alternative program teachers have a higher turnover rate (Darling-Hammond, 2001; Ereksom & Barr, 1985; McKibbin, 1991; Shen, 1997), while others indicate higher retention rates among

The wide diversity of nontraditional approaches that falls under the umbrella of “alternative” is problematic when analyzing their overall effectiveness. Regarding this dilemma, Windschitl (2005) asserts teacher education requires careful articulation and word choice:

“Teacher preparation” means many different things across the country and the same is true for “alternative” preparation programs which vary in their content, duration, and structure. “Traditional” teacher preparation has been an undergraduate model while the label “alternative” applies to such a spectrum of programs that the term is meaningless when used to suggest the quality or length of a program. Some of these routes are “alternative” to the notion of preparation itself in that they dramatically lower expectations for candidates’ content and pedagogical knowledge, and in many cases shift decisions about candidates’ competence to the employing school districts. Other alternative routes include various post-baccalaureate models, such as 5th-year master’s degree programs that have integrated theory and skill development even more productively than most traditional programs. Such alternatives to the undergraduate program design typically meet or exceed normal licensing standards. (p. 531; emphasis added)

Researchers report inconsistent results and conflicting conclusions due to the hodgepodge of advertised alternative certification programs. Nevertheless, one can derive noteworthy themes from the research. These traits provide insight into the general condition of teacher education, especially with respect to the historical landscape already presented.

To some extent, the alternative certification replays the origins of formal teacher education in America. Almost two hundred years ago, normal schools began with the sole purpose of efficiently supplying a nation in desperate need of teachers. During that time and now, public schools have a dire need of teachers. They do not have much luxury in selecting top-notch candidates. Many schools will accept whatever and whomever they can get. Like normal schools, many alternative education programs feature “fast-track” systems that churn
out teachers (Goodlad, 1990c; Windschitl, 2005). The emphasis is on technical skills and quick-fix practices, without addressing conceptual foundations for educational decision-making (Altenbaugh & Underwood, 1990; Windschitl, 2005). The overall result is intellectually handicapped teachers who perpetuate mechanistic schooling before leaving the field (Laczko-Kerr & Berliner, 2002; Raymond, Fletcher, & Luque, 2001). Classrooms remain stagnant and windswept from the rapid succession of instructors.

The high turnover rate of alternatively certified teachers is significant, since shortages are due more to retention and not recruitment (Ingersoll, 2003; Windschitl, 2005). This is akin to pouring more water into a bucket without ever addressing the hole in the bottom. Regrettably, it is a growing practice in the current age of attrition and accountability. Government and education leaders are leading the push. Newman (1990) notes that “state legislatures and state boards of education have proven themselves more than willing to bend teacher education and certification in order to put warm bodies in front of the classroom” (p. 62). One can only question and fear the impending instant when the strained system eventually breaks altogether. More disturbing, perhaps, is the spirited support and encouragement of this trend. Policymakers have recently increased their backing of alternative certification as a lasting standard of operation in place of academic preparation. Former U.S. Secretary of Education Rod Paige offers these words concerning teacher preparation: “A model for tomorrow would be based on the best alternate route programs of today” (U.S. Department of Education, 2002, p. 19). One must look, then, at such examples of the best that alternative certification has to offer.

A closer inspection of programs acclaimed as successes actually reveals traits common to any effective preparation, not just those exclusive to alternative certification.
Jorissen’s studies (2002, 2003) of urban alternative credentialed teachers report the following elements as key for producing committed, long-term teachers: pre-internship coursework, intensive extended field experience lasting two or more semesters, daily classroom participation opportunities, intern experience with “expert” classroom teachers, collaboration with experienced teacher mentors/supervisors, encouraged and expanded interaction with preservice cohorts, methods professors that explicitly model competent teaching behaviors, and “structures and relationships to negotiate the major tasks of career transition” (p. 48).

The necessity of providing meaningful, extensive field experiences supports past research, which report that short-term programs generate low retention rates (Darling-Hammond, 2001; McKibbin, 1991).

Teachers from short-term certification programs have inadequate abilities in the areas of classroom management, student motivation, teaching methods, and curriculum development (Darling-Hammond, 2001; Feiman-Nemser & Parker, 1990; Grossman, 1989; Lenk, 1989; Mitchell, 1987). The same causes and effects would be true regardless of the traditional or alternative nature of one’s teacher preparation. Goodlad (1990c) expresses a caveat regarding teacher preparation programs that are brief in time and broad in scope:

It is unlikely that mere exposure to a few courses in education and a brief immersion as a student teacher will suffice. And the folly of trusting the quality of the teacher-student relationship to a few generic principles now becomes sharply apparent. Generic knowledge of teaching that might be applied in a whole host of teaching situations—by instructors of cosmetology and beauty schools, by teachers of diesel engine care, by dog trainers, by drill sergeants, by public school teachers—embraces only a very small part of what teachers of the nation’s children and youths must know and be able to do. The very claims of a pedagogy so universally applicable to all teaching trivialize the wide variations in the significance and complexity of the forms of teaching listed. The trivialization is complete when those versed in such teaching promise to pass it along to others in a matter of hours or days (or however long a time the market will bear). (p. 50)
Out of these concerns, Goodlad and his colleagues formulated the following postulate (one of nineteen) regarding conditions necessary for successful teacher preparation: “Programs for the education of educators must be protected from the vagaries of supply and demand by state policies that allow neither backdoor ‘emergency’ programs nor temporary teaching licenses” (1990c, p. 63). Educating teachers—whether through traditional means, alternative methods, or otherwise—requires an extended time commitment essential for the examination, self-reflection, and practice of instructional decision-making.

One distinct genre of alternative avenues is post-baccalaureate certification, where individuals with a bachelor’s degree or higher in a specific content field such as biology or chemistry engage in a twelve- or eighteen-month certification program (Baron & Rusnak, 1990). Participation in this “fifth year” of intensive study occurs partly on campus and partly through field experience, or practicum, in schools. Upon completion of the program, students often receive graduate-level degrees, the Masters of Arts in Teaching, or MAT (Chen, Paige, & Bhattacharjee, 2004). In a way, the post-baccalaureate or MAT model is the fulfillment of early university professors’ preference of preservice teachers already having a subject degree (Borrowman, 1956). With the case of science, many MAT candidates are engineers, biologists, or chemists already holding advanced degrees and now pursuing certification. As quoted above, Windschitl (2005) reports that these programs can be even more successful than traditional approaches, especially when an integration of learning educational theory and developing teaching skills exists. Again, such effective amalgamation need not be—and in many cases is not—restricted to alternative programs.

Universities, colleges, and other sites of “traditional” teacher preparation can indeed aspire to implement these components in their programs. Such traits are not exclusive to
alternative education. In fact, many developed through the progression of normal schools, teachers colleges, and universities (Borrowman, 1956, 1965; Goodlad, Soder, & Sirotnik, 1990; Harper, 1939). The inclusion of K-12 teachers as college instructors and the expanded use of field experiences are two “alternative” practices recently revived by traditional programs (Blair, 2003). Some of these elements, though, were cast off through the years. Teacher educators grew distracted and forgot fundamental ingredients. Perhaps the greatest benefit of the alternative push is a reawakening of core teacher education tenets. The danger, however, lies in pushing marginal methods too far.

The wide diversity in alternative programs obfuscates a clear picture of truly effective teacher preparation. The prospect of any approach having a lasting, positive impact is even more problematic when considering the fuzzy state of formal teacher certification in general. The certification process of American teachers is fragmented and geared toward the lowest common denominator concerning standards (Lanier & Little, 1986). Requirements vary among states and teaching specialties. Feistritzer (1984) diagnoses the present situation more bluntly: “The certification of classroom teachers in the United States is a mess” (p. 36). It is impossible to encapsulate the broad spectrum of certification standards. Coming to agreement on an engaging, encompassing improvement plan is an even greater feat. Yet, one can and must reflect on the possible fissures alternative certification forces into the sphere of teacher preparation.

Craven & Penick (2001) are critical of compressing teacher preparation into the “expedient operations” found in alternative certification. They claim these programs “do little more than undermine public and private conceptions of the profession, teachers and those that teach teachers” (p. 1). Research on the high turnover rates and low performance of
alternative alumni supports these assertions. Furthermore, the current turn toward alternative means may lead to more disastrous developments. Windschitl (2005) elaborates on the hidden dangers stemming from alternative certification of teachers: “The logic behind forgoing preparation depends on a view of teaching as a second-class profession or a short-term public service ‘gig’ rather than as an intellectually demanding career in which one develops as a professional over years” (p. 527). In Windschitl’s words, the present attitude is a “serious ethical” dilemma impacting future of education and society.

Teaching is not a temp job. It is far from a simple “gig.” Teaching is a noble profession, and it requires the noblest efforts from societies and individuals. Those who daily educate scores of students face relentless demands from cognitive, emotional, and physical realms (Graves, 2001; Jansma, 1996; Leinhardt & Greeno, 1986; Schwartz, 2005). Decisions occur continuously regarding instructional strategies, content appropriateness, classroom management, individual assessment and learning, and procedural requirements (Bransford, Brown, & Cocking, 2000; Clough, 2003b, 2003c; Clough & Berg, 2006; Clough & Kauffman, 1999; Watson & Konicek, 1990). The challenge is continuous and extends beyond the classroom, as teachers face stresses ranging from local to national interests (Collinson, 2004; Sutton, 2004).

To assume individuals can develop these complex understandings and intricate abilities through a concise, hasty regimen is imprudent. This flawed position is even more hazardous in the current culture which—much like the era of the normal schools and afterward—does not fully understand or support the need for special preparation in becoming a teacher (Book, Byers, & Freeman, 1983; Borrowman, 1956, 1965; Feiman-Nemser &
Floden, 1986; Lanier & Little, 1986; Lortie, 1975). Perhaps the truest admonition about both alternative education and the current culture comes from Goodlad (1990c):

Ours is the kind of society that thrives on alternatives. Because of the importance of teacher education to this society, however, alternative conditions deemed necessary to it must be carefully deduced. Reforms not carefully thought out, reforms passed along without careful analysis, have already gotten our educational system into much difficulty. (p. 53)

Society’s livelihood depends on successful education of its citizens. Successful education relies on qualified teachers with complete comprehensions and tested abilities. Teacher preparation must recognize and implement the methods necessary to raise teachers to this level. The following sections examine these efforts, including an analysis of recurring themes in both historical in present contexts.

**The Current State of Science Teacher Education**

Current conditions are grim. The cover story of a 2006 *Time* magazine issue asks the question, “Is America flunking science?” The accompanying article—asking another question, “Are we losing our edge?”—describes how U.S. students are trailing global competitors in the areas of scientific innovation and advancements (Lemonick, 2006). Education is the most commonly scrutinized entity in these matters.

**By the Numbers**

In analyzing statistics on science education and educators, one soon recognizes the ominous consequences. Sullivan (2006) provides the following statistical summaries related to science education (p. 1):

- In a 2004 U.S. Department of Education survey, 30% of responding teachers indicate that they rely more on information learned from their high school science classes to support their teaching than any science course they had in college.
In physical science courses, 16% of high school students and 48% of middle school students studied with a teacher who did not have a major or minor in physical science, engineering, or a related field.

Other analyses predict future calamity. By 2012, approximately two-thirds of all American teachers are expected to retire or stop teaching (Daggett, 2006; Sullivan, 2006). More than 200,000 of these positions are in the math and science fields (Olson, 2000). The situation is even more severe for minority teachers, who constitute less than 10% of the total U.S. teaching population (Lanier & Little, 1986). Studies indicate that the number of minority teachers is declining at a time when the percentage of children from minority backgrounds is increasing in American schools (NEA, 1982). A shortage of science teachers continues nationwide (Craven & Penick, 2001; Shymansky & Aldridge, 1982; Windschitl, 2005).

Shymansky and Aldridge (1982) report that the decade between 1971 and 1980 featured a 64% decline in the numbers of individuals pursing teaching degrees in science. In the 1981-82 school year alone, 50% of all science and math teacher hires were done through emergency procedures (Shymansky & Aldridge, 1982).

Attrition again rears its head. For U.S. teachers in general, one fifth leave within their first three years of teaching, and nearly 30% leave in five years (Darling-Hammond, 1999; Mangrubang, 2005). The same research indicates that these turnover rates are even higher for “disadvantaged” schools. The effects of attrition have a greater impact on the already limited supply of science teachers, especially under-represented groups of minorities and women teachers in some science areas (NSTA, 2004a). Job dissatisfaction is a primary culprit causing teacher turnover (Mangrubang, 2005; Weiss, 1999; Yee, 1990). This is especially true for science and math teachers (Ingersoll, 2003). Furthermore, job dissatisfaction plays a key role in choosing to leave the field for teachers of all experience.
levels. In a survey of 1,370 secondary science teachers, slightly more than one third of all respondents indicated consideration of quitting their education career (NSTA, 2000). This percentage was consistent for teachers in experience levels of 1-3 years (32%), 4-6 years (37%), 7-9 years (33%), and 10-15 years (37%). For science teachers with more than 20 years of experience, 44% considered leaving the profession, job dissatisfaction being second on their list of reasons following retirement. At a time when science educators are in great demand, their supply is diminishing rapidly.

**Quality of Science Teaching**

Numbers notwithstanding, the actual quality of teaching in classrooms is a sobering issue. Scarce supply yields ill-equipped teachers and poor student performances (NCTAF, 1997). The following conclusions were made from the extensive study of schools and teaching, directed by Goodlad (1983, 1984):

- Teachers use a limited repertoire of pedagogical strategies, mostly relying on “teacher talk” and monitoring of seatwork.
- On average, students experience two hours of “teacher talk” during a five-period day.
- In the high school classroom, teachers typically “out-talk” their students by a ratio of three to one.
- Classroom interaction is described as neutral or flat.
- Feedback or guidance with the purpose of helping students understand and correct errors is “almost nonexistent.”
- Both pedagogy and curriculum tend to steer toward the “lowest common denominators” of learning.
- In the typical classroom, students are rarely responsible for planning or initiating anything. In addition to scarce creativity, limited communication and collaboration takes place among peers during learning and investigation.

In choosing and evaluating instructional effectiveness, teachers often cite personal style as their sole basis, often relying on previous experiences as students (Lortie, 1975). The effects of these generalizations increase in bleakness when one takes into account one more conclusion from the Goodlad study:
Teachers teach as they were taught. They employ the techniques and materials modeled during the 16 or more years they were students in schools. Relatively late in this learning through modeling, they experienced a modicum of professional preparation to teach—presented largely in the same telling mode to which they had become accustomed. (1983, p. 468; emphases in original)

As addressed earlier and will be noted again, teacher education is unique due to the exposure potential educators experience throughout their lives. Unfortunately, such contact acts as a contamination more than it does as an inspiration or ideal archetype.

The contagion of ineffective education continues to spread. Weiss, Pasley, Smith, Banilower, and Heck (2003) studied 364 sample mathematics and science lessons in grades K-12 and found sobering results that echo the research of Goodlad (1983, 1984). In the summary of their study, Weiss et al. concluded the following:

Lessons judged to be low in quality are characterized by learning environments that are lacking in respect and/or rigor; questioning that emphasizes getting the right answer and moving on, without also focusing on student understanding; and “just starting” with no particular motivation and “just ending” without summarizing or other sense-making. (Weiss et al., 2003, p. 104)

The quality of science lessons varies with respect to the classroom context. Lessons used in classrooms from a rural setting, with high percentages of minority students, and/or with “low
ability” students were typically lower in quality. Defective curriculum and instruction remain.

In part due to such unengaged teaching and the persistent “prestige deprivation” of education, teachers often fail to articulate their instructional decisions or provide credible support for these actions (Fullan, 1996; Olson, 2004). Additionally, when teachers face inevitable challenges, they find themselves in a precarious situation of self-evaluation, at a crossroads between recognizing their failures and blaming their preparation. Lortie (1975) describes this divergence teachers experience as “seeing themselves as incompetent and seeing their prophets as false” (p. 69). As Lortie notes, most teachers in this position choose the latter option, and the paradigm of mediocrity ensues. Even the degrees of teacher credentials—graduate work, discipline certifications, professional licensures, etc.—have no recognizable effect on the outcomes of students’ cognitive skill development or achievement scores (Xin, Xu, & Tatsuoka, 2004). Such patchiness is especially apparent in the science classroom, as identified by Yager and Penick (1983) in their summaries of science education studies performed by the National Assessment of Educational Progress (NAEP, 1977):

- Student interest in science decreases progressively as students move from elementary to middle school, and again from middle school to high school.
- Science is taught with the sole purpose of advancing to the next level of formal study of science.
- Nearly all science teachers employ a philosophy based on one specific discipline of science.
- More than 90% of all science teachers use the textbook 95% of the time, relying on the book to organize and dictate learning and assessment.
- Almost 90% of all high school graduates are scientific or technologically illiterate.

Yager and Penick (1983) detect several fundamental problems from analyzing these data, such as limitations of exclusively relying on the textbook, the narrow-minded portrayal of science which ignores the human component, failure to move beyond lecture format, lack of
investigation and a disconnect between the classroom and laboratory, as well as students with
the following experience: “the longer they stay in school and the more science they
complete, the greater is their disillusionment with the ultimate value of their studies” (p. 69).
Conversant of such portentous data, these authors and others claim school science is in a state
of crisis (Brinckerhoff, 1982; Shymansky & Aldridge, 1982; Yager & Penick, 1983). Craven
and Penick (2001) assess the present state of science education with respect to science
literacy goals:

For today, increasingly complex scientific and technological issues challenge our
global society. The present quality of life is, and in the future will continue to be,
affected by such issues both old and new. Yet the models of science education that
widely persist in schools across the grade levels (including the college science
classroom) are inadequate for developing the knowledge needed to tackle those
problems. Those models largely fail to truly engage most students in the learning
process; their consequences on student outcomes are disastrous. Students not
engaged in the learning process leave with little more than shallow understandings,
weak connections between the big ideas, trivial knowledge, unchallenged naïve
conceptions of how the natural world operates, and an inability to apply knowledge in
new settings. As a result, students do not develop the ability or propensity to become
self-regulating learners or inquirers. (p. 1; emphasis added)

The University Impact

The history of teacher education has culminated in the present circumstances. The
university system and its various foibles exemplify the existing state of teacher preparation,
many of which are similar to problems of the past 150 years (Cuban, 1993; Lanier & Little,
1986). Teachers tend to teach how they were taught (Goodlad, 1983). In the typical
education classroom, preservice teachers are not taught well. As mentioned earlier in the
discussion of the university system, most education professors hold higher value in studying
future teachers rather than educating them. A mismatch of priorities is clearly evident.
“Prospective teachers want to learn how to teach; they are not aspiring to be educational
historians, philosophers, psychologists, or sociologists. Many of the professors of education they encounter early on, however, are precisely such specialists” (Goodlad, 1990c, p. 213). As such, universities possess scarce representation of what effective teaching should entail. Education students, especially those in science, undergo a litany of lecture-based classrooms with limited student-teacher or student-student interaction. Even pedagogical methods courses in specific content areas for preservice teachers frequently follow the lecture format (Goodlad, 1990b, 1990c). After experiencing such lackluster preparation, teachers consistently rank their university professors below cooperating teachers as to the impact created on their preparation (Goodlad, 1990c) and, in general, devalue the worth of their formal preparation (Bureau of Educational Research, 1983; Lanier & Little, 1986; Lortie, 1975). “Alas, a widespread complaint of teachers and future teachers is that teachers of teachers are less than experts in the teaching craft and often fail to practice what they preach” (Goodlad, 1990c, p. 75; emphases added).

The “Do as I say, not as I do” approach to teaching methods is not only detrimental due to the absence of exemplary teaching. It also curbs growth in other traits necessary for effective instruction. Confining education students to inactive audience roles hinders any development of self-reflective and self-motivated teachers (Goodlad, 1990c). Furthermore, it carries on the production of “intellectual paraplegics” as described by Postman and Weingartner (1969):

The [future teachers] are the ones who were most “successful” in conventional school terms. That is, they are the ones who learned best what they were required to do: to sit quietly, to accept without question whatever nonsense was inflicted on them, to ventriloquize on demand with a high degree of fidelity, to go down only on the down staircase, to speak only on signal from the teacher, and so on. All during [this education], they learned not to think, not to ask questions, not to figure things out for themselves. They learned to become totally dependent on teacher authority, and they
learned it with dedication. . . . Naturally, this is what leads to trouble when they are confrontusted with an opportunity to do what they must, to wit: make viable meanings in order to make, in turn, viable choices and decisions of their own, on their own. (p. 143)

New teachers change roles from usually reactive student to an active decision-maker (Bergman, 2006). Munby and Russell (1993) describe this uneasy shift as “a transition from being under authority to being in authority” (p. 9). The prior inculcation to be submissive and meek makes this switch all the more overwhelming. Poor modeling and submissive schooling persist in creating bungling teachers. As Goodlad (1990c, p. 256) notes, “little intellectual wave-making” in teacher preparation program yields the same inaction in teachers’ classrooms and schools. Those who profess to educate effective teachers are not, in fact, admirable teachers themselves.

Such disparities are not relegated only to teacher behavior and practice. It also occurs in curriculum and leadership. Like submissive students, teacher education reveals a nature of passivity, being “certificate responsive rather than internally driven” (Beatty, 1990, p. 211). Teacher preparation programs are widely varied both within and among institutions nationwide. Included in this miscellany are ambiguous, incomplete goals as well as a lack of any clear educational mission (Goodlad, 1990c). The unfocused stance is due in part to uninformed and unconcerned professors. Often, faculty members from arts and sciences colleges have neither input nor interest in developing an educational mission. Ignorance toward standards for preservice teacher enrollment and curriculum is far too prevalent. “It appears that many faculty members in the arts and sciences are ill-informed about teacher education requirements on their own campuses” (Goodlad, 1990c, p. 237). The organization of education curriculum relies on separate approaches by departments (educational
psychology, foundations, curriculum and instruction, etc.) and individual professors.

Students find themselves adjusting their perspectives and efforts to fit the varying expectations of their courses and instructors. The impact of the present program ambiguity on teacher preparation can be ruinous and resilient:

> Curriculum development in teacher education is largely absent, inadequate, primitive, or all of these. In the absence of accessible relevant knowledge and potent curricula, both the teacher educator and the teacher are left to their intuitive and practical interpretations. Because intuition is capricious and in short supply among humans, it is not surprising that both teacher education and teachers are unduly influenced by what appears to work for them or others, has been part of their own experience as students, is well packaged and marketed, or is required by an empowered regulatory agency. (Goodlad, 1990c, p. 267)

Goodlad labels such incoherence in curriculum and its planning process as “indefensible.”

The consequences described here are extensive and will be addressed in view of recurring themes in teacher education. At present, however, a lack of consistent curriculum and mission leads to another outcome in the current system. Ill-equipped teachers become followers, not leaders, in the realm of education. The leadership abilities of teachers remain unused and uncultivated (Quinn, Haggard, & Ford, 2006). Goodlad (1990c) expresses concern over “the general inability of [education] students, regardless of institutional type, to engage in intelligent, informed discussion of educational issues, even at the point where they impinged on teachers’ decisions” (p. 252). Such stunted capacity results from the way programs prepare future teachers. Goodlad shares observations of what preservice teachers do and do not learn:

> Their preparation programs were not deliberately developing the skills of discourse, debate, analysis of conflicting views, compromise, and the like required by faculties engaged in school renewal. But students were, by almost everyone’s admission, learning a good deal about how to go it alone in a classroom with a group of children or youths. (1990c, p. 255)
Teachers most likely learned this solitary approach from the disconnected behaviors modeled among their professors. The continuing conflict among academic and professional advocates has created barriers among university departments, courses, and personnel (Borrowman, 1956; Lanier & Little, 1986). An isolated program yields isolated teachers. Even the institutional system itself promotes an introverted education: “One does not generally find . . . on college and university campuses a process through which students planning to teach are socialized together into the teaching profession” (Goodlad, 1990b, p. 28).

Student teaching continues the system of independence. Su (1986) summarizes the current state of teacher preparation’s fieldwork component:

The organization of the training program, especially the structure of the student teaching experience, also tends to encourage the development of teacher individualism. . . . The image of student teachers . . . is an aggregate of persons learning to teach on their individual motivation and initiatives. The student teachers confront a “sink-or-swim” situation in physical isolation. The way most beginners are inducted into teaching therefore leaves them doubly alone. (cited in Goodlad, 1990c, p. 211; emphases added)

At present, the student teaching experience is not the idealized opportunity to apply reform-oriented, research-based understanding in the classroom. Rather, the solo student teacher latches onto “how it’s done,” the traditional approach presented by the cooperating teacher and found to be easiest to follow (Goodlad, 1990c). Lortie (1975) notes that three ingredients of teacher preparation persist in limiting intellectual growth and meaningful reform: conservatism, individualism, and presentism. Lasing improvement stalls due to these inhibiting factors, modeled for teachers by preservice educators and cooperating teachers (Bergman, 2006; Fu & Shelton, 2002; Kauffman, 1992; Sullivan, Mousley, & Gervasioni, 2000; Talvitie, Peltokallio, & Mannisto, 2000).
As teacher educators are models for preservice teachers, so are universities models for smaller state colleges and institutions.

Appropriately or not, the regionals model themselves after the major universities, apparently unable to define a distinctive mission for themselves. Thus they perceive progress to be leaving behind what they were in order to become what they probably cannot and should not become. (Goodlad, 1990c, p. 193)

The results of teacher education’s current state are not encouraging. The combination of a lack of identity on the institutional level and isolated individualism on the personal level produces meager results. In addition to the effects on teacher abilities listed earlier, the quandary also afflicts school systems in general. Goodlad (1990c) describes the relationship between university campuses and school districts as “tenuous.” The collaborative strains continue into the realm of professional development, which often maintain isolation in their programs and lack durability (Moore & Hyde, 1981; Schlechty & Crowell, 1983). Scholar segregation continues: “Staff development is not tied to the central obligations, opportunities, and rewards of work in the district, school, or profession and offers few career rewards to those who emerge as its leaders” (Lanier & Little, 1986, p. 562).

As in the normal school era, districts prefer teachers with ingrained, competent technical skills. The academic abilities and understanding promoted by teacher educators fall to the wayside in favor of technique and management. Once teachers find themselves in a school classroom, they are more apt to comply with district expectations for management and supervision, even at the expense of student learning and school improvement (Lanier & Little, 1986). Such a disjointed system provides reason as to why most teachers view their formal preparation programs as inadequate (Eddy, 1969; Fuchs, 1969; Goodlad, 1990c; Griffin & Hukill, 1983; Little, 1981; Lortie, 1975; Ryan, 1970).
When examining the impoverished conditions of teacher education, one may become tempted to jump to any of the alternative certification programs presently brandished. The degree of mainstream teacher preparation is not the issue, however. Much deeper principles are at work. Goodlad (1990c) recalls the parallels among teacher preparation today and the state of medical schools a century ago:

Teacher education . . . like medical education in 1910, is something not yet seriously attempted. The fact that it is not commonly being well done in the universities is not a convincing argument for taking it away from them, however. Rather, we should study what is wrong and lay out what should be—and then do for teacher education what has already been done with notable success for medical education, always remembering, however, the fundamental differences between the medical and the educating professional. Not to do so will be to perpetuate teaching as, at best, the not-quite profession and to ensure continuation of the school practices that political, business, and educational leaders believe to be turning us into a second-rate nation. (p. 226; emphasis in original)

Simply altering the venue, schedule, or regulatory “standards” of teacher education will not improve results. The subject is much more complex and requires astute examination.

Through America’s two centuries of organized teacher education, problems of learning, teaching, and schooling have not aged well.

**Themes and Trends in Teacher Education**

Much like recent alternative certification efforts echo the initial normal school movement, several recurring themes underlie and overarch the evolution of teacher education. The road to progress has suffered its share of potholes, u-turns, and detours:

The age-old quest for a discipline of education has been marked by conflicts, false starts, and disappointments. Most of the perplexing issues which arose in the early decades remain, though their form has changed somewhat and they have been complicated by a host of other factors rooted in the profound changes of American culture. (Borrowman, 1956, p. 228)
As history repeats itself, it presents key issues that lead to the current situation. The following paragraphs present and inspect core themes in teacher education. These issues have existed since the age of the normal school (Cuban, 1993; Lanier & Little, 1986). A study into the trends provides insight into fundamental matters steering and succeeding teacher education.

**Teacher Preparation’s Identity Crisis**

The start of normal schools in 1840s America marked the first era of institutions created only to prepare teachers. “Until the advent of the normal schools, no concrete sense of teacher competency, let alone teacher training, existed” (Altenbaugh & Underwood, 1990, p. 137). This select purpose gave normal schools a distinct identity. Learned et al. (1920/1965) cite the 1878 Report of the Superintendent of Public Schools concerning normal schools: “No effort has been spared to make the institution exclusively a school for teachers” (p. 186). Such exclusivity also gave the normal school system much needed support. “Its laurels were won by conforming itself to the evident needs of the people” (Harper, 1939, p. 97). Normal school graduates neatly filled a need for classroom disciplinarians. They were quality products from an efficient, specialized operation, idyllic of the Industrial Revolution. The diversification of normal schools, though, ended their distinction from other institutions. A loss of identity was indeed “positively disastrous” for the institutions’ livelihoods (Learned et al., 1920/1965).

Since the end of normal schools and their fleeting offspring teachers colleges, no other exclusive teacher preparation format has functioned at such a massive degree. For that matter, teacher education has been unfocused, unstudied, and overshadowed ever since (Goodlad, 1990c; Sarason, Davidson, & Blatt, 1986). The splintering of teacher education
has blinded institutional vision, stifling educators’ speech and interest. “Institutional evolution from normal school to teacher college to state university has largely disenfranchised faculty members commonly held accountable for teacher education from the undergraduate curriculum. They have little or no voice in it” (Goodlad, 1994, p. 141). Dissonance among institutional aims and faculty interest creates dissatisfaction and, ultimately, diminishing returns. Weakened teacher preparation yields weak teachers. Teacher preparation becomes “everyone’s and no one’s responsibility, and its power thus remains diffused” (Lanier & Little, 1986, p. 560). Fractured teacher education programs offer diluted and digressing courses.

There is not for teacher education a faculty with influence sufficient to ensure a reasonably connected and integrated program of (1) general and professional studies, (2) observations of practice, and (3) supervised teaching experience—all driven by a clear mission and agreed-upon goals. (Goodlad, 1990c, p. 246)

Instability not only clouds any vision of teacher education, but it also undermines its institutional security (Goodlad, 1990b). Floundering departments and colleges of education find themselves in muddier and deeper waters. The decrepit state of teacher education crumbles further.

**The Curriculum Debate**

Normal schools were essential in establishing credibility for a formal teacher education program. Indeed, had normal schools not succeeded, teacher preparation may have fallen to the wayside, unnoticed by post-secondary institutions. “It is clear that the American colleges and universities did not take seriously the business of professional preparation for teachers until the normals had developed that field” (Harper, 1939, p. 114). Normal schools, however, had focused most of their teacher preparation efforts on managerial techniques.
General education was judged necessary only to the extent to which teachers needed to share specific knowledge with their children. “It was enough that the teacher should have a sound knowledge of the subjects taught in the elementary school, be virtuous, industrious, dedicated to work, and obedient to superiors” (Woodring, 1975, p. 9). These latter qualities were valued even more than any academic understanding or scholarship. “Character training therefore superseded intellectual concerns at the normal schools” (Altenbaugh & Underwood, 1990, p. 140). The combination of these traits formed the notion that a certain “art” to teaching exists. Nevertheless, even supporters of normal schools had recognized the need for teachers to have a foundation of academic understanding.

While the young teacher will depend largely upon imitation and practice to master the techniques of his art, and while the normal school in consequence must first of all provide abundant opportunities for the successful mastery of technique in this empirical fashion, it should not be forgotten that the teacher should be something more than a craftsman. (Learned et al., 1920, cited in Borrowman, 1956, p. 174).

Educators acknowledged that teaching requires abilities extending beyond artistic flair. Effective teachers possess more than mere technical skills. Yet theory and academic study were set aside in favor of procedural training.

A gap remained between practice and theory. Normal schools opted for the former, much to the chagrin of universities. In fact, the current conflict of views toward teaching has its roots in the transition between these institutions:

The old emphasis on the art of teaching and on subjects to be taught in the common schools had gained a strong hold on the attitudes of the normal school people before [education theory] arose to challenge it. When the new disciplines were developed they were promoted by the university people who tended to look down on the normal school. The stage was thus set for the bitterness which has marked the attitude of the technicians and theoreticians toward each other. (Borrowman, 1956, p. 63)
As universities assumed control of teacher preparation, professors shifted the emphasis from vocational practice toward academic scholarship. It was an attempt to enlighten educators from the presumed blinders of normal school technicians. “Because the normal schools felt the necessity of placing the child in the center of their program, it became a belief in many quarters that normals were merely schools of ‘methods’ and did not stand for scholarship” (Harper, 1939, p. 131). The hostilities did not originate from only one side, however. Normal schools actively advertised their pride of preparing a profession, a vocation of teaching. Furthermore, normal schools—and teachers colleges later on—were careful to avoid “aping the liberal arts colleges and thereby losing those distinctive characteristics upon which the state teacher-education institutions were originally founded, and upon which their phenomenal success had been built” (Harper, 1939, p. 130). Both sides claimed they produced the best results, often basing judgment on their particular values. The debate rages as to what extent teacher preparation requires professional and/or academic components.

Much of the controversy relies on fundamentally different views regarding what it required to be an effective teacher. On one side is those who believe teachers need specific knowledge and skill to successfully accomplish their instructional duties. The extreme face of this perspective asserts that potential teachers “know nothing, absolutely nothing, of the complicated and difficult duties” in the classroom unless they have “literary and scientific” training (Carter, 1826/1967, p. 153; 1866/1967, p. 428). Others argue that any individual obtaining a general education will jointly acquire the capacity to teach. “Bright people can teach naturally, according to this argument, and dull people who try to teach are just asking for trouble” (Newman, 1990, p. 53). This ongoing conflict, which Harper (1939) describes
as a “fierce debate regarding professional and academic courses,” has been the basis for much criticism toward formal teacher education ever since its origins. Harper elaborates:

The normal schools were harassed for years by two contradictory lines of attack. On the one hand were those who claimed that anyone who knew a subject could teach it; hence, there was no need for special teachers’ schools. On the other hand there were in the early days many sincere friends of the normals who held that only strictly professional courses should be taught in these institutions. They believed that the normals should offer nothing except methods and education courses. (p. 108)

Very few individuals considered looking to research to support their arguments or inform decisions. Curriculum had been mostly ignored by teacher educators, who failed to agree or consider the most effective content to teach teachers.

Although there is now a massive body of research relevant to learning and teaching, it had not previously been connected to the tasks teachers face and the decisions they must make. There had been no agreement among teacher educators over what knowledge (from the mass of research data available) was most likely to empower teachers. (Goodlad, 1990c, p. 15)

Borrowman (1956, 1965) attempted to enumerate the assorted perspectives toward teacher education. Although starting with four categories (1956), he eventually streamlined his historical analysis to “three sets of prevailing attitudes regarding the relationship between liberal and professional studies” (Lanier & Little, 1986, p. 547). Borrowman regards the first grouping as the “purist position.” This set is divided into two subcategories. Some argue for academic or general education only. Liberal arts faculty, then, should disregard any professional interests for the classroom setting. Academic purists “were apt to argue that when the college or academy had provided thorough instruction in the subjects to be taught and an example of good teaching methods the teacher was adequately prepared” (Borrowman, 1956, p. 68). The other half of the purist position seeks teacher preparation that is strictly professional. “On the professional school side, it meant that all instruction
should be rigorously tested for its contribution to competence in classroom teaching” (Borrowman, 1965, p. 26). Both academic and professional purists “insisted that the professional school should not dilute its efforts by trying to provide both liberal culture and professional training” (1965, p. 26). The purists seek teacher education consisting of two separate parts, professional and technical preparation coming after students have completed their general, or liberal, studies.

A second category of attitudes toward liberal and professional studies is the integrated approach. The namesake describes the perspective held by these individuals, “who believed the distinction between liberal and professional studies to be a false one” (Borrowman, 1965, p. 26). Integrators advocated a unified program in which future teachers learned both content and pedagogy simultaneously. “Very shortly people holding this position became aggressive defenders of general education made up of professionally treated lower branches intermingled with professional instruction of a technical and ultrapractical nature” (Borrowman, 1956, p. 69).

Borrowman refers to the final set of attitudes as “the eclectic or ad hoc approach” (1965, p. 39) and labels its supporters “harmonizers” (1956, p. 68). Like the integrators, this third group considered it possible to provide preservice teachers a general and professional education at the same time. The harmonizers “believe that both should be begun fairly early in the student’s collegiate career and should continue throughout the undergraduate and graduate programs” (1965, p. 26). The difference between this view and that of the integrators is that harmonizers push for explicit distinction between academic and professional education. A student in this system would have separate courses and curricula. Even though such a program would be divided, students could still develop academic
understanding through both routes. “From [the harmonizers’] point of view a curriculum could be functionally oriented to a significant degree and still be liberalizing” (Borrowman, 1956, p. 69).

The segregated approach, whether through the purist or harmonizer means, remains prominent in teacher preparation’s history and present. Borrowman had diagnosed this, noting the presence of a “widespread tendency to avoid pressing for agreement on an overarching principle” (1965, p. 41). Keeping interests separate and evading conflict are easier. Yet avoidance limits discourse and progress. “The integrated approach requires more cooperation among potentially hostile faculty and involves the risk of significant compromise. But separated approaches also tend to keep the professional education component more clearly technical and less defined as an area of liberal study” (Lanier & Little, 1986, p. 547). Despite harmonizers’ intent, a fully separate program does inhibit the academic and intellectual components of teacher preparation.

The questions remain. What nature of curriculum is most meaningful in successfully preparing teachers? In what ways does a teacher use both professional skills and academic understanding in effective instruction? How do technique and scholarship compare? How do they interconnect? James Earl Russell, dean of Columbia’s Teachers College from 1897 to 1927, had characterized the apparent dichotomy in terms of the teacher’s considerations of the student and content: “The academically-minded teacher asks what the subject will do for the student; the professionally-minded teacher asks what the student will do with the subject” (1924, cited in Borrowman, 1965, p. 210). Still, no clear consensus remains regarding what teachers must learn in order to successfully instruct students. Gage (1972) describes the complex capacity of understanding and skills required of teachers:
Much of what teachers must know about teaching does not directly follow from a knowledge of the learning process. Their knowledge must be acquired explicitly rather than by inference. Farmers need to know more than how plants grow. Mechanics need to know more than how a machine works. Physicians need to know more than how the body functions. Teachers need to know more than how a student learns.

Teachers must know how to manipulate the independent variables, especially their own behaviors, that determine learning. Such knowledge cannot be derived automatically from knowledge about the learning process. (p. 62)

Teaching is more than just knowledge of subject matter. Teaching is more than understanding how people learn. It requires application. Yet it also demands understanding beyond simple procedures and austere techniques.

The query lingers, awaiting an answer to disclose ingredients for ideal teacher preparation. Borrowman (1956) argues that the debate between general academic education and technical professional training has impeded the growth of teacher education throughout its history. His recommendation is to seek a balance that explicitly links the two domains. This approach would yield desired progress and bypass the encumbering dispute.

The problem is to organize the preservice experience of potential teachers so efficiently that maximum understanding and control of the forces at work in educational situations are achieved along with a safe margin of technical skill. This is the issue of the liberal and the technical in teacher education.

To see the problem whole three areas must be kept in focus: (1) the concept of general education, (2) the relationship of the professional to the general education sequence, and (3) the balance sought between the liberal and the technical emphasis in the professional sequence. To make decisions concerning one area without concerning their implications for the other two seems most unreasonable. However, [history] indicates that such judgments are frequently made. (1956, p. 229)

Each educator has their own paradigm of teaching, each giving various relative weight to the academic and professional aspect of teaching. Russell (1925/1965) likens this to being “born either pedagogical blonds or brunettes” (p. 210). Even so, one must acknowledge that
effective teacher education requires both theoretical and pragmatic components. Ignoring one in favor of giving exclusive attention to the other produces incomplete teachers. Either they hold scholarly understanding and lack skills for implementation, or they are masters of technique but incapable of diagnosing, reflecting, and even recognizing the complex constituents of classroom instruction.

In addition to curricular equilibrium, pedagogical prototypes must be explicitly laid before students. As mentioned earlier, many university classrooms lack effective modeling by the instructors. This is true—and especially detrimental—for classes geared toward teaching methods. A lecture on teaching the finer points of instructional strategies and decisions sends mixed messages. Students may receive the concept, but they have no model of application. Classes on education must feature the best teachers. Goodlad (1994) furthers the argument against faulty instruction by education faculty:

> [L]arge classes taught by inexperienced teaching assistants have no place in the education of teachers in a nation that claims for schooling powerful leverage in maintaining the image and the reality of its leadership role, nor do the didactics and the passivity that characterize such a large part of undergraduate teaching and learning. (p. 177)

The archetypal instruction by teacher educators is not only necessary for ideal representation. Engaging preservice teachers in classroom discussion, investigation, and discourse is vital for developing the highly sought after academic understanding and professional skills. As past research has revealed, new teachers often face an alarming transition from reactive to proactive participants in education (Bergman, 2006; Munby & Russell, 1993). This shock should not happen. Instead, teachers must have a history of functional thinking, examining, and leading throughout their student careers.
The need for engaged learners in education preparation has been noted over the decades. This includes recommendations of the Commission on Teacher Education during the era of transitions from normal schools to teachers colleges to universities as primary suppliers of teachers. After almost a decade of experimentation and investigation in twenty post-secondary institutions and fourteen public school systems, the CTE concludes teachers must learn in an active setting.

A teacher whose own education has been mostly a matter of passive acquiescence in programs and procedures predetermined by his instructors is not likely easily and effectively to lead his own pupils to share responsibility in the planning of their educational experiences. Prospective teachers particularly, therefore, should be treated as persons, as capable of participating intelligently in the determination of their own educational courses. (CTE, 1946/1965, p. 244)

A half-century has produced limited results, as Goodlad (1990a, 1990c, 1994) reports teachers still learn in one-sided, inert classrooms. Stodgy classroom modeling is a by-product of the unresolved curriculum quandary. Concentrating efforts to address both this deliberation and the instructional behaviors of professors will assuredly escort teacher education toward improved conditions.

A final component to address in the realm of curriculum is student teaching. Some semblance of practice teaching, or field experience, has been a part of teacher preparation since the normal school years. The bulk of preservice teachers’ time in the classroom has historically occurred at the end of the program, as a capstone of sorts. Harper (1939) explains the rationale for this approach, another instance in which teacher preparation is compared to medical education:

It is perfectly clear that future teachers should spend sufficient time in the practice and demonstration school to master the necessary skills in the use of the essential tools of the teaching art.
It is believed in modern teachers colleges that students should be introduced gradually to the varied duties and activities of the teaching art. Observation, apprenticeship, and full responsibility should come in proper sequence. The medical education program without clinical facilities and without internship would be as unthinkable as teacher education without the practice phases. (p. 158)

Much discussion has risen as to the time allotted for student teaching and classroom experience. Although Harper conveys the attitude of educators toward supplying ample school experience, he fails to elaborate what counts as “sufficient time” in practice. Dewey (1904/1965) cautions premature exposure to classroom responsibilities, as it may stunt preservice teachers’ intellectual development and professional capabilities. Unprepared teachers may revert to “empirical tricks,” described by Borrowman (1956, p. 179) as a habit that confines instructional flexibility and future progress. Yet student teaching remains an essential piece of any preservice teachers’ preparation. As agreed upon among Dewey, Harper, and other teacher educators, student teaching is most advantageous when placed at the appropriate time(s) in a teacher’s education. Considerations include the prior experiences and learning of preservice teachers, as well as the possibilities of concurrent coursework in which competent teacher educators help preservice teachers analyze and improve their teaching. A prerequisite to practice teaching, argues Dewey, is an introduction to and understanding of epistemological and pedagogical foundations:

It should go without saying that the student who has acquired power in psychological observation and interpretation may finally go on to observe more technical aspects of instruction, namely, the various methods and instrumentalities used by a good teacher in giving instruction in any subject. If properly prepared for, this need not tend to produce copiers, followers of tradition and example. Such students will be able to translate the practical devices which are such an important part of the equipment of a good teacher over into their psychological equivalents; to know not merely as a matter of brute fact that they do work, but to know how and why they work. Thus he will be an independent judge and critic of their proper use and adaptation. (1904/1965, p. 156)
Practice is necessary, but it is meaningful only during and after proper preparation. Introducing new teachers to the classroom too soon or without appropriate assistance ends in lackluster results. This is especially true of the present conditions in which cooperating teachers are rare and often poor models of truly effective instruction (Bergman, 2006; Goodlad, 1990c; Talvitie, Peltokallio, & Mannisto, 2000). Teacher educators put themselves in a precarious position when relying solely on student teaching to shape teachers. At best, it is a gamble to match the student teacher with an exemplary cooperating teacher. At worst—and more probable—it handicaps the student teacher to follow the poor model of another struggling instructor. “Thus, student teaching, the capstone of a candidate’s entry into the profession, the scale by which candidates measure what they have been taught and conceive of what is possible, is generally geared to the status quo” (Levin, 1990, p. 75). From this perspective, then, one must embrace the role of student teaching portrayed by Dewey. In addressing the push of practice teaching by the Herbartian and Oswego movements, Dewey (1904/1965) presents his argument against an apprenticeship slant in favor of a more intellectual experience, the laboratory approach. As described by Lanier and Little (1986), the laboratory approach uses the student teaching time “to give the [preservice teacher] the theoretical principles necessary to understand social and ethical issues in teaching, how children learn, how curriculum decisions might be guided, and how students’ cognitions might influence teaching” (p. 551). Unfortunately, the current state of student teaching leans toward promotion of management and technical skills. Lanier and Little speculate on the long-term effects of this approach:

Emphasis on mastery of management skills may well be adaptive for a teaching population where few teachers remain long in the classroom, but it appears to have serious consequences when career teachers are the norm. What is not learned,
apparently, is the set of intellectual tools that would allow teachers to evaluate the quality of the education they are provided, or to critically evaluate suggestions for improvement. A model of field experience consistent with the liberal-professional approach to teacher education would strive to produce a deeper understanding of the way theoretical concepts from psychology, curriculum, and sociology are played out in classrooms. Such understanding of children, subject matter, and schools would enable teachers to provide better instruction, make better curriculum choices, and participate on a stronger footing in policy debates. Keeping the classroom under control is important, but good management alone does not focus teaching on children’s higher order thinking needs. (1986, p. 551)

This discussion is notable in the current age of teacher attrition and ineffectiveness. Again, the curriculum debate between academic and vocational champions plays out among the struggling profession. Student teaching is a capsule of this larger contest. In fact, field experience can and must be a vital step in a teacher’s education and professional preparation.

Dewey (1904/1965) regards both the use and provisos of effective student teaching:

> It is necessary to recognize the importance for the teacher’s equipment of his own habituation to superior types of method of mental operation. . . . Only a teacher thoroughly trained in higher levels of intellectual method and who thus has constantly in his own mind a sense of what adequate and genuine intellectual activity means, will be likely, in deed, not in mere word, to respect the mental integrity and force of children. (p. 160)

**Ebb and Flow**

Student teaching a hundred years ago was quite similar to what occurs in the present. Student teachers have opportunities to build relationships with students; partner with a cooperating teacher; observe and interact with faculty, parents, administration, and the community; and visit with other practice teachers and instructors in seminar settings (CTE, 1946/1965). The primary difference between then and now was the time commitment. In the mid-1900s, the time of student teaching ranged from three to nine weeks. Although variation existed among institutions, this time is considerably diminutive compared with the present practice of twelve to sixteen weeks. Ever since the handful of months some teachers
spent in normal schools (Harper, 1939), the duration of preparation programs has generally increased over the years. Despite the debates teacher educators hold regarding curriculum, they do agree that students need time to develop mature understandings and abilities of instructional practice (Borrowman, 1965). When demand for teachers is high, however, short cuts often form.

The age of normal schools is similar to the present circumstances in that both eras coincide with a time of teacher shortage. In this way, the alternative certification movement is akin to the brief normal school stints of most early teachers. Both practices defy the general notion that teachers need multiple years of preparation to complete their education and training. A common aspiration of both eras is equipping teachers with the ability to cultivate productive citizenship out of their students. One recalls the fervent campaigning of statesmen such as Mann, Webster, and Franklin toward establishing the normal school system. From the training of teachers, this new institution was a means of saving democracy indirectly and ultimately in America’s youth. Echoes of these sentiments remain and resound today: “The school is the only institution in our nation specifically charged with enculturating the young into a political democracy. The education of teachers must, therefore, be specifically directed toward this end” (Goodlad, 1990c, p. 48). Before educating these teachers, however, one has to find them. The parallels between normal schools and the present continue.

Harper (1939) relays the concerns of normal school principals in securing qualified candidates: “the problem of getting good recruits for the teaching profession was a serious one” (p. 53). Harper describes the traits of normal school students at the turn of the twentieth century. “The entrance requirements among the earlier schools were generally: good health,
minimum age of sixteen to eighteen years, certificate of good moral character, and an examination on the common branches taught in the district schools” (p. 105). As standards for enrollment have increased, the numbers of teacher candidates fluctuate with various social changes. The years between 1900 and 1930 featured immense population explosions among students.

While the total number of children of school age was increasing by about 50 percent [sic], the enrollment of young people in public high schools increased eightfold. . . . Consequently, an increasing percentage of the college educated people were needed to man the high school classrooms. (Borrowman, 1956, p. 128)

Expansion of student populations occurred again following World War II, creating growth within colleges and departments of education (Beatty, 1990). However, the diminishing need for teachers during the 1970s truncated the very same teacher preparation institutions (Goodlad, 1990c; Levin, 1990). By this time, a university or state college had swallowed up nearly every school once exclusive to educating teachers. As a result, the first cutback victims were undergraduate teacher certification programs. Leading into the twenty-first century, many universities have disproportionately trimmed education programs in favor of research or graduate-level offerings (Beatty, 1990; Goodlad, 1990c).

The supply-and-demand for teachers has indeed swayed with historical changes. Teacher education institutions have followed these oscillations, though they find it difficult to rise out of the furrows. Student and teacher populations will continue to fluctuate over the course of time. Nevertheless, a common theme has ascended across the decades, as conceded by Harper (1939): “there is a shortage of good teachers” (p. 161; emphasis in original). As Ingersoll (2003) and Windschitl (2005) have noted, the dearth of educators is
due to failed retention, not deficient recruitment. Finding good teachers is not the main problem. The issue is keeping them in the classrooms.

**Cycles of Reform**

Similar to the ebb and flow of teacher placement needs, attempts at reforming teacher preparation have also vacillated. Goodlad (1990b) offers speculation as to why reform efforts ultimately result in holding patterns:

> The call for reform in teacher education is as repetitive as that for reform of schools—in diagnoses and proposals as well as cycles. As a consequence, whether our interest be in the fate of recommendations made frequently during the past or in that of unusual ones, there is rarely much in contemporary discourse to help us predict the consequences of reforms’ reappearance. . . . Perhaps it is the nature of reform to look ahead with hope undiminished by sobering lessons from the past. (p. 4)

It may be that past attempts were so fixated on the labored fruits that prior experience and insight were forgotten. Tyack (1989) argues that most educational historians fail to scrutinize the impact on and effects of teachers and teaching. Goodlad (1990b) lumps teacher education into these overlooked ingredients. Another injurious trait of reform efforts is the extended amount of time required for change. This is especially true for the multifaceted realm of academia. “It will be a long time, if ever, before most institutions preparing teachers commonly produce students with [a] balanced general curriculum. . . . Curriculum development in higher education moves slowly, free of a sense of urgency” (Goodlad, 1994, p. 147). Again, education’s unique disposition appears to hinder its own progress.

The social arrangement of teaching is another aspect that limits reform efforts. The amount of isolation a typical classroom teacher experiences—as discussed earlier—can act as a barrier toward growth (Goodlad, 1990b; Su, 1986). Cuban (1993) notes, “the act of
teaching within a self-contained classroom, isolated from colleagues, fosters conservatism” (p. 254). Such separation is not true solitary confinement. Teachers do have opportunities to interact and foster dialogue. Even so, the limited contact with other teachers is not always beneficial. Cuban elaborates on the birth of a teaching career:

The private and lonely anguish of the sink-or-swim ordeal that usually consumes the newcomer’s first few years is alleviated by occasional advice and sharing of anecdotes by experienced colleagues. From the very first day, facing the complicated process of establishing routines that will induce a group of students to behave in an orderly way while learning subject matter that the teacher is still unfamiliar with, the teacher is driven to use practices that he or she remembers seeing used or that veterans advise using. By taking such advice, entrants absorb through a subtle osmosis the school’s norms and expectations about what it takes to survive as a teacher. The folklore, occupational gimmicks, norms, and daily teaching reinforce existing approaches rather than nourish skepticism, especially if one wishes to continue in the job. Thus, teacher-centered classroom practices tend to be stable over time. (p. 254)

The information and examples new teachers receive are consistent with what they experienced since their first day in kindergarten. Early and extended exposure to the teaching profession creates an extensive notion of the occupation (Goodlad, 1990a, 1990c; Lanier & Henderson, 1973; Lortie, 1975; Sarason, 1981). “Twelve or so years of elementary and secondary school provide opportunities to receive messages about what teachers do” (Feiman-Nemser & Floden, 1986). One would hope these years are ideal recruitment opportunities with a captive audience. Unfortunately, many of those who embrace the profession do so because of fondness for the status quo.

Cuban (1993) observes, “Recruits to the occupation lean toward continuity because of their prior school experiences. As public school students for twelve years, future teachers unwittingly served an apprenticeship as they watched their teachers teach” (p. 19). Those who enter education often maintain the same ineffective habits as their predecessors.
Additionally, such new teachers have limited experience with diverse aspects of the common life. Instead, as Postman and Weingartner (1969) describe, “most of them simply move from one side of the desk (as students) to the other side (as ‘teachers’) and they have not had much contact with the way things are outside of school rooms” (p. 139).

Yet these teachers do have ideas, particularly about how to teach. Their decade and a half of schooling results in an elaborately constructed notion of how education works. As Cuban (1993) describes, these constructions emphasize a mostly traditional and flaccid model of instruction and curriculum. Like most preconceptions, ideas about education are held tightly by future teachers. This is equally true for practicing teachers. Classrooms contain an abundance of challenges and “are unforgiving crucibles for testing ideas” (Cuban, 1993, p. 260). Often, teachers are preoccupied with maintaining order and keeping up with the daily grind. They are not prepared to enact change. Instead, teachers maintain previously held ideas, even while struggling through their frustrations and failures. Paradigms established since kindergarten are persistent. “The student’s reluctance to abandon his or her perspectives, even at times when they conflict with other developing ideas is one of the great challenges teacher educators face” (Craven & Penick, 2001, p. 3).

Most students—including future teachers—have never reflected on their hidden views of schooling. Likewise, these students are never challenged to inspect their ideas and search for the most accurate, fundamental understandings and applications of learning and teaching. Recognizing students’ elaborate constructions of prior knowledge, assumptions, and the ensuing implications, Feiman-Nemser and Floden (1986) propose a change in the approach to teacher education:
Consideration of teachers’ tacit knowledge suggests a shift in the balance between teacher education and teacher training. The success of behaviorally oriented research on teaching encourages a technical skills approach in teacher preparation and renewal. Though technical skills are valuable, research on the cultures of teaching suggests that much of what teachers know does not fit the means-ends statements that summarize process-product research on teaching. Teacher education must build on or rebuild what teachers and teachers-to-be already believe about their work. (p. 523; emphases in original)

A cry for balancing technical skills and conceptual understanding occurs, a reemergence of the perennial curriculum crux. In developing techniques and management skills, teachers need to practice and hone their abilities. With regard to instruction and planning, however, teachers must develop a conceptual understanding to frame their decisions. In order to construct this framework, they first must examine their prior notions and move toward more accurate knowledge.

Simply presenting pedagogical topics or techniques to students with no investigation or reflection is not enough. The bare result of that approach is fragile teachers with in flimsy, fickle ideas about learning and teaching. Craven and Penick (2001) conclude, then, that “a fundamental role of science teacher educators is to get preservice and inservice [teachers] to think about their own explicit and tacit thoughts about schools, science education, teaching, and learning” (p. 3). Conceptual change requires learners being dissatisfied with their misconceptions (Hewson & Hewson, 1984; Postman & Weingartner, 1969). Furthermore, learners must investigate intelligible, plausible, and fruitful concepts and applications in education (Henriques, 1997; Posner, Strike, Hewson, & Gertzog, 1982). Teacher educators must create an environment in which teachers are motivated to change their incorrect notions of education (Pintrich, Marx, & Boyle, 1993). Lasting, successful change will transpire in
such conditions. Transformation occurs not only in teachers’ knowledge and practice, but also in schools. This is when durable educational reform finally happens.

Previous attempts at reform fail because preservice teachers experience no revolution of deep-seeded ideas about teaching and learning. Fads and shallow schemes make ripples before fading away as quickly as they came. Improving education requires conceptual change in each individual during teacher preparation. This must be the goal of every teacher educator. It is the standard to which one judges meaningful learning.

The ability to learn turns out to be a function of the extent to which one is capable of perception change. If a student goes through four years of school and comes out “seeing” things in the way he did when he started, he will act the same. Which means he learned nothing. (Postman & Weingartner, 1969, p. 121)

What Postman and Weingartner express here has been present since the beginning of formal teacher education. Quick fixes pass by and promptly find themselves “relegated to the graveyard of attempted school reforms” (Cuban, 1993, p. 260). One could annex an equally sized plot for the mixed efforts of teacher preparation institutions.

But teacher education is not dead yet. Goodlad (1994) provides a different analogy. It is a recall of the cyclic pattern found in reform itself (Goodlad, 1990b, 1990c). The same chronic loop occurs at another level. Goodlad speaks of the “perplexing demands” faced by teachers, as well as the criticisms and obstructions of meddling policymakers. The bulk of both parties lack any conceptual change experience toward conceiving and mastering effective education.

The net effect is a curricular racetrack along which future teachers scurry, looking always for opportunities to shorten the distance to the finish line. They have little time for sustained reflection; that they will become reflexive practitioners appears exceedingly doubtful. (Goodlad, 1994, p. 165; emphasis added)
Without revelation and revolution, educators maintain their futile rotation. This is true among all levels—classrooms, college campuses, and capitol buildings. Reform stopgaps will continue to sway alongside the ebb and flow of society. Permanent progress, however, requires cultural conversion among populations’ fundamental concepts of learning and teaching. John Dewey recognized this truth over a century ago: “The thing needful is improvement of education, not simply by turning out teachers who can do better the things that are now necessary to do, but rather by changing the conception of what constitutes education” (1904/1965, p. 171).

Prior Research into Teaching and Education

Parallel to numerous reform efforts over the decades, researchers have made diverse attempts to research the arena of teacher preparation. What follows is a summary of the most recognized studies of teacher education, including some in the realm of science education. No nationwide audit of teacher preparation institutions has been conducted yet. However, a handful of educators, researchers, and organizations have attempted various means to examine the education of future educators. Reviewing these seminal studies provides insight both into the state of teacher education and the methods used in such research.

The Education of American Teachers (1963)

In the 1960s, former Harvard president James Conant led a two-year investigation of the education of teachers (Conant, 1963). Interestingly, this endeavor was also supported through a grant from the Carnegie Corporation, much like Flexner’s work with medical schools a half-century earlier. Conant’s team visited 77 institutions in 22 states. These teacher preparation programs came from a variety of settings: church and non-church private colleges and universities, state universities and colleges, and municipal colleges. Although
most teachers were and still are educated in public institutions, these colleges and universities comprised only 38% of Conant’s study, with church-based institutions being 44% and non-church privates making up the remaining 18% of studied institutions. Methods included interviews with professors, education students, classroom teachers; document analysis of program catalogs, course syllabi, and textbooks; and classroom observations of education courses. The second year focused extensively on state regulations and teacher certification from the 16 most populous states.

With special attention to the education of secondary teachers, the following recapitulate major findings from Conant’s study:

1. Preservice students take a common core of required courses, usually in the following sequence: history and/or philosophy of education (or some form of introduction to American education), educational psychology, general methods of teaching, and a block of student teaching. However, extreme variation exists in the required hours of such classes as well as the content taught.

2. Required methods courses (including special methods for particular subjects) ranged from 3 to 11 semester hours among the studied institutions. Although not as fragmented and redundant as methods for elementary teachers, these courses altogether exhibit “mindlessness” toward professional education curriculum for secondary teachers.

3. Education departments often house disputes over resources and boundaries with regard to methods courses, especially those in subject fields for secondary school teachers.

4. The range in practice teaching requirements is 4 to 11 semester hours. Inconsistencies abound among institutions with respect to required clock hours in classroom teaching (part-time and full-time) as well as credit hours.

Preservice students interviewed in Conant’s study gave negative responses regarding their introductory education courses. A perceived lack of relevance was the primary reason for disdain. Regarding education courses in general, Conant summarizes the curriculum as such:
The programs in many institutions seem to have been developed not by careful consideration of a group but by a process that might be called *academic logrolling*. . . . One finds a complete lack of agreement on what constitutes a satisfactory general education program for future teachers. As to the education in a specific field which the college student expects to teach, there is far greater degree of unanimity. (1963, p. 209; emphasis added)

Conant’s study of state government and teacher certification yielded additional data and analysis concerning the state of teacher preparation. Space is not given here for sufficient discussion, although noteworthy is that this half of his research resulted in many policy recommendations that even today may be considered revolutionary.

Conant categorized his concluding observations of teacher education according to suggestions for different stakeholders. For state education departments, he addresses certification requirements, practice teaching programs, and information services. To state legislatures, Conant discusses financial considerations for practicing and future teachers. Local school boards are addressed mostly about the development and education of their teachers, including development of an extensive induction program for probationary teachers as well as financial and institutional support for inservice education of all teachers. The bulk of Conant’s suggestions, however, are for teacher preparation institutions:

1. An “all-university approach” to educating teachers, including professionally and academically qualified faculty for education classes.

2. Justification for degree requirements of future teachers, including alignment of subject-specific content with the requirements of the field (mathematics, science, history, literature and composition, etc.).

3. A correct balance of depth and breadth in content and methodology for elementary teachers. This includes ample practice experience and supervision.

4. A master’s degree program for teachers that is compatible with teachers’ school schedules and summers and that has standards equivalent to other masters-level programs such as comprehensive examinations and subject-matter fields.
(Incidentally, Conant was also a pioneer in the Masters of Arts in Teaching, or MAT graduate-level certification approach.)

5. Establishing “clinical professors” described as such: “The professor from the college or university who is to supervise and assess the practice teaching should have had much practical experience. His status should be analogous to that of a clinical professor in certain medical fields” (1963, p. 214).

Conant did believe in continuation of courses in history and philosophy of education. However, he was critical of survey classes that pitched a hodgepodge of topics at an insufficient surface level. These sorts of courses, though, actually became more common in the decades to follow (Sirotnik, 1990). Conant’s call for “clinical professor” appointments in teacher education came from a firm belief in practice as both preparation to teach and a means to determine final admittance into the profession. Goodlad (1990b) notes that this clinical approach has recently resurfaced in popularity, while Conant’s initial recommendation “went nowhere” (p. 4).

Conant’s study was the first—and still one of the very few—of its kind; however, most of his suggestions for improving teacher preparation institutions never transpired or resulted in the anticipated outcome. In comparing differences over the years, John Goodlad, a collaborator in Conant’s research, labels some of the initial programmatic proposals for educating students “sadly anachronistic,” noting that both the “world and schools have changed” (1984, p. 139). In short, the Conant Report is remembered most as a national criticism of teacher education in 1960s America (Hendrick, 1990).


Perhaps the most comprehensive study of K-12 American education was the 1980s project known as “A Study of Schooling.” This venture was headed by John Goodlad—dean of UCLA’s Graduate School of Education at that time—and provided the groundwork for his
later studies in teacher education. First, however, Goodlad and his colleagues made an intensive effort to understand the complex arena of K-12 education. This includes moving beyond measuring student achievement and giving attention to dynamics such as “curricular offerings, pedagogy, student-teacher relations, school and class climate, principal-teacher relations, parental satisfactions and dissatisfactions, and a host of other highly important matters” (Goodlad, 1984, p. xvii). The data sources came from 38 schools from 13 communities in 7 different regions of the country. Schools were from a range of sizes and districts, including urban, suburban, and rural settings. More than 20 trained data collectors visited each community for almost a month. With the goal of creating “thick descriptions” of these schools and their communities, methods included surveys of parents, teachers and students; classroom observations (2-3 periods for high schools and middle schools, 2-3 days for elementary schools); and interviews with teachers. Science constituted 12% of the samples taken from secondary school classes.

The creation of thick descriptions for each school yielded a plethora of data for examination. Regarding the classroom and instruction, Goodlad (1983, 1984) made several conclusions from this extensive study. These findings were discussed earlier with respect to the quality of instruction in America, and include items such as teachers using limited strategies, outtalking students, providing little feedback, and dominating decisions and class dialogue. Such conclusions created an interest in the teacher’s role and ultimately, the preservice education of these teachers.

Places Where Teachers Are Taught (1990)

Goodlad turned his attention to teacher preparation programs at post-secondary institutions. He and his colleagues published more findings nearly ten years after “A Study
of Schooling.” The research into teacher education initially began in 1985, with one goal being “a comprehensive study of the conditions and circumstances of educating educators for the nation’s schools” (Goodlad, Soder, & Sirotnik, 1990, p. xi). The study involved 29 colleges and universities of various sizes and types including public and private institutions, major and regional state universities, and small liberal arts colleges. Each researcher performed extensive case studies of the programs he or she studied. Specific methods included document and historical analysis, questionnaires for students and faculty members, observations of the education activities at the institution and cooperating schools, and interviews with institution administrators, professors, supervisors, cooperating teachers, and other school personnel.

Similar to their study of schooling and “A Place Called School,” the Goodlad team’s research into “Places Where Teachers Are Taught” generated many conclusions describing the state of teacher preparation (Goodlad, 1990a, 1990b, 1990c; Goodlad, Soder, & Sirotnik, 1990). The following list provides a comprehensive summary:

1. Many institutions have discontinued or diminished teacher preparation in favor of research and graduate-level programs.

2. Teacher preparation programs have ambiguous missions and incomplete goals, with faculty members unclear about teacher education requirements.

3. Teacher educators have no consensus on what knowledge and skills are most useful and meaningful for new teachers.

4. Programs and courses emphasize teaching as a solitary profession (“teacher individualism”), neglecting discourse, compromise, and discussion of ideas.

5. Teacher education curriculum is fractured, unbalanced, and slow to change in response to reform efforts.

6. Teacher preparation institutions and schools often have feeble, strained relationships.

8. Education students experience lecture-based classrooms (general and education courses) with limited interactions between students and with the teacher.

9. Cooperating teachers are scarce and often model ineffective instruction.

10. Most teachers view their formal preparation programs as inadequate.

The information gained from examination of how professors teach and develop their education classes is insightful. A review of Goodlad’s conclusions about teacher preparation crystallizes the observations of teaching and classrooms found in the “Study of Schooling.” Parallels occur in several strands, including instructor-student interaction, instructional behaviors, curriculum and program development, and the outcomes of these quirks. Both of these studies—massive as they were—examined schools and teachers in general. As noted above, in “A Study of Schooling,” slightly more than ten percent of observations were of science classrooms. The study of teacher preparation did not differentiate among content-specific programs.

*Salish I (1997)*

A final study to review is unique in that it did focus exclusively on science teacher education. The Salish I Project (Brunkhorst, Yager, Brunkhorst, & Apple, 1993; Salish I, 1997) was an exploratory study of nine universities and their recent secondary science education graduates. Methods included classroom videotaping and observation of science teacher graduates, interviews with these teachers about their preservice program experiences and pedagogical philosophy, and surveys of both teachers and their students about the nature
of science, a constructivist learning environment and, for students, classroom goals (Salish I, 1997). Craven and Penick (2001) summarize major findings of the Salish I study:

1. Inconsistencies abound among education faculty members’ philosophies of education.

2. Instruction and evaluation in many courses outside science education are not aligned with practices promoted by the National Science Education Standards (NRC, 1996).

3. New teachers report limited or no connection between practices and concepts taught in content courses and teacher education courses.


In analyzing the results of the Salish I study, Craven and Penick recommend the following programmatic changes in science teacher education: (1) collaboration among faculty, including clarification of roles in various departments; (2) articulation of goals and philosophy among program faculty members; (3) coherence among all coursework and field experiences; (4) consistent methods of instruction and assessment among the entire program; (5) authentic research experiences in education and science settings for preservice students; (6) cohort programs designed with ample time for students to reflect on and communicate their experiences and understandings; (7) connections between theory and practice, strengthened by exchanges among university faculty, schoolteachers, administrators, and students; and (8) feedback through surveying and studying graduates to inform program changes and improvements (2001).

The Salish I study is noteworthy because of its specialized examination of secondary science teacher preparation. Issues have emerged, however, concerning the reliability of data from the graduates participating in Salish I. Those questioning the project’s trustworthiness
include individuals who were a part of the Salish research team (Duggan-Haas, 1998). Strategies used by some Salish researchers may have biased results: paying participating teachers an honorarium, purchasing books and resources requested by teachers, assisting teachers in administering student instruments and “in other ways,” and arranging social events connected to the teachers’ school responsibilities (Salish I, 1997). Furthermore, participants volunteered to be a part of the study, which may create an inaccurate portrayal of the science teacher population graduating from these nine institutions. “It seems reasonable to assume that volunteers for such a study would be more aligned with the culture of teaching. . . . Certainly, by using volunteer subjects, the data do not reflect the total population of new science teachers in every aspect” (Duggan-Haas, 1998, p. 2). These participants may be positively biased toward their education programs and could show higher motivation and quality of teaching. The population of graduates not participating may exhibit varying instructional competencies. Some, in fact, may not be teaching at all. A sound, complete study of graduates from secondary science teacher education programs remains unachieved.

**Research Recommendations**

Anderson and Mitchener (1994) recognize a deficiency in quality and quantity of research into preservice science teacher education. Cochran-Smith and Zeichner (2005) broaden this dearth to include research on teacher education in general. McNerney and Imig (2006) note, “Through the years, neither the funding nor the results achieved by such work have been particularly notable” (p. 2). No study has yet encompassed key issues such as teacher behaviors, pedagogical knowledge, student learning, and their relationships with teachers’ preservice preparation (Wilson, Floden, & Ferrini-Mundy, 2001). Recent research
usually has limited relevance due to narrow focus within one institution or program.

Cochran-Smith (2004) attributes the inadequacy of these studies to an inability to generalize toward broader applications in science teacher education. In 2006, another study of teacher preparation began, called the Teachers for a New Era (TNE) program (McNergney & Imig, 2006). Interestingly, TNE is partially funded by the Carnegie Corporation of New York, the same institute that funded research by Abraham Flexner (1910) and James Conant (1963).

TNE arrives at a time when teacher education faces even greater scrutiny for results. TNE supports 11 institutions of higher education and their school partners in efforts to determine what, if anything, teacher educators do to help teachers help students learn. . . . Like it or not, teacher educators must face the specter of being judged irrelevant if they cannot demonstrate that they add value to the PK-12 educational enterprise. (McNergney & Imig, 2006, p. 1; emphases added)

TNE has the potential to indicate how much impact teacher education institutions truly have on teachers and, subsequently, student achievement in U.S. schools. Yet its focus is broad on all subjects and all ages of students. Its insight into secondary science teacher preparation may be limited and unexplored.

Upon evaluation of trends in science teacher education and its accompanying analysis, Windschitl (2005) outlines several recommendations for improvement. These actions are necessary for developing truly functional research on the field:

1. Distinguishing among relative influences of individuals’ “entry characteristics” (subject matter knowledge, pedagogy, dispositions and beliefs about learning and learners, etc.) before beginning a teacher education program and the traits and skills developed through completing the program.

2. Developing a clearer picture of how preservice components improve and/or hinder resulting teacher performance. This includes the sequence and extent of various program elements.
3. Investigating the impact of assorted field experiences in both teacher behavior and student learning. What are the roles of coursework curriculum, cooperating teachers, and additional influences and interactions?

4. Assimilating the entire scope of a teacher education program as “a continuum of learning, including undergraduate studies, teacher education coursework, field work with cooperating teachers, induction, and a career of professional development” (p. 530). Furthermore, what is the nature of the transitions among these phases?

A vital consideration is determining what criteria and data are most useful for research purposes. Craven and Penick (2001) provide the following index for systematically collecting evidence of program outcomes:

1. Trends in employment of the graduates of the program including location, subjects, type of schools;

2. Feedback from school administrations and district officials regarding the skills and understandings of recent graduates from the program;

3. Feedback from all the partners involved in the preparation program;

4. Feedback from recent graduates including self-perceptions;

5. School-based performance indicators from new teachers and their students; and

6. Performances on portfolio evaluations, videotapes, and/or other measures required for state certification. (p. 8)

The above recommendations and guidelines were used to inform the present study, which investigated the effects of one science teacher education program (ISU SSTEP) and its subsequent modifications. Common trends of past research reveal teacher dissatisfaction toward their preparation programs, correlating with unclear program goals, standards, instructor roles, and curriculum content (Conant, 1963; Goodlad, 1990a, 1990b, 1990c; Goodlad, Soder, & Sirotnik, 1990; Salish I, 1997). The secondary science teacher education program at ISU has taken action to resolve such inconsistencies. Although limited to
examining this one institution, the present study seeks to address existing research concerns as it investigates the core issues of effective science teacher preparation.

**Habits of Mind in the Face of Uncertainty**

An underlying impetus of the Iowa State University Secondary Science Teacher Education Program (ISU SSTEP)—the focus of this study—is creating the appropriate conditions that push students to develop the understandings, skills and habits of thinking necessary to successfully implement effective education (Clough, 2003b). This emphasis on the teacher comes from the foundation of research on the classroom teacher’s role as change agent in education and social improvement (Clough, 2003c; Clough & Berg, 2006; Gunzenhauser, Lindner, Harris, & Kersting, 1994; Husu, 2002; Krisko, 2001). Skillful thinking of students and teachers does not simply occur through maturation (Case, 1992). Critical, reflective thinking must be taught (Kassem, 2005), an endeavor not easily accomplished. Past and present attempts to simplify teaching, albeit tempting, are admonished due to the potential misdirection given to future teachers (Buchmann, 1988). Teachers prepared through such methods develop insufficient understandings of the multiple complexities of the classroom environment, how to transition pedagogical knowing into practice, and the effective implementation of appropriate activities and communication for learning (Buchmann, 1988; Burbules, 1990; Floden & Buchman, 1993; Reid, 1979, 1999; Waks, 2000). Such educators revert to trial and error methods in their classrooms, relying on probability to find success. Unfortunately, most teacher education institutions continue to prepare such teachers through simplified means. From his research into teacher education, Martin (1989) claims the number of universities authentically promoting higher order thinking skills curriculum in preservice teachers is a half-dozen at best. Proposals for
reforming teacher education often parallel such simplified, inadequate content (Gunzenhauser et al., 1994).

Teaching involves active, instantaneous decision-making in the classroom context of uncertainty. Helping teachers develop the understandings and skills to successfully function in such an environment is equally complex and confusing. Shulman (1986b) describes the discombobulating effect of delving into the complex dynamics of classroom teaching.

Reinforcement and conditioning guarantee behavior, and training produces predictable outcomes; knowledge guarantees only freedom, only the flexibility to judge, to weigh alternatives, to reason about both ends and means, and then to act while reflecting upon one's actions. Knowledge guarantees only grounded unpredictability. (p. 13)

As a result, Shulman notes that teacher educators themselves need to develop their own understandings and skills: “Instructions in [teacher preparation] areas will have to improve dramatically to meet the standards of understanding required for teaching” (1986b, p. 13). Teacher education that strives to surpass simplicity often stumbles and resorts to implicit and ambiguous instruction. In the end, teachers with either simplified or befuddled backgrounds remain in a haze of guesses and blind actions (Husu, 2002). The complex nature of learning and teaching requires teachers to be decision-makers, and that those decisions are made in light of the classroom situation at hand and research on effective teaching.

Many terms have been used to describe such a framework. In the science teacher education program of the present study (ISU SSTEP), “Research-Based Framework (RBF) for Teaching and Learning Science” (Clough, 2003c; Clough & Berg, 2006; Clough & Kauffman, 1999) is used as a visual tool to convey the research-based framework upon which teacher decision-making is based. ISU SSTEP faculty have deemed (1) understanding, (2) action, (3) reflection, and (4) having and enacting an action plan for
improving practice as the four general habits of mind promoted, modeled, and advocated in
their program.

Other general titles for a framework of teacher understanding and ability are frames of reference, skillful thinking, habits of mind, habits of practice, and habits of thought. Kassem (2005) describes this sophisticated structure as “characteristics and dispositions of self-regulated learners” (p. 14), citing Ennis (1987), who labels it as the “critical spirit of critical thinking.” Moreover, such habits bring some sense of order from which a teacher can approach mercurial learning environments. Husu (2002) cites an Aristotelian term—
*phronesis*—to label this “ability to deal with the dynamics of practical situations. . . . It is a kind of knowing that can be understood as embodied judgment linking teachers’ knowledge and their virtue” (p. 6). Husu continues her elaboration of *phronesis*, a term of prudence that she argues has no modern equivalent in English:

*Phronesis* goes beyond both analytical, scientific knowledge (*episteme*) and technical knowledge or know-how (*techne*) and involves judgments made in living social contexts. It addresses the ways that people act in everyday situations and deals with human action in terms of practical situations. The stance focuses on the question “What should I do in this situation?” (p. 7)

Lindner and Harris (1992) address particular tasks and actions of teachers with such a frame of reference. Teachers, as well as learners in general, have “(1) the ability to monitor, regulate, evaluate, sustain, and strategically modify, when necessary, the learning process and (2) sensitivity to, and ability to exercise control over, contextual factors that affect learning outcomes” (cited in Gunzenhauser et al., 1994, p. 5). Much of this cognitive and methodological framework comes from definitions of thinking developed by Socrates, Dewey, Bloom, and others (Kassem, 2005). Critical inquiry, questioning, reflective thought, and higher order thinking are all key ingredients of productive teaching habits of mind.
Describing Habits of Mind

Similar to physical characteristics and subsequent patterns of movement, habits of mind “yield patterns of thought, intuitions, images, intentions” (Margolis, 1993, p. 8; cited in Martinello & Cook, 1994). Particular habits of mind have been articulated by many (Cook, 1996; Martinello & Cook, 1994; Sizer, 1992). These particular traits include habits of mind in both cognitive and affective realms. Cook (1996, p. 48) provides the following list that—while being not exhaustive—describes common categories of habits of mind.

Cognitive habits of mind:
1. Finding and keeping focus
2. Simplifying questions and problems
3. Attentiveness
4. Thinking fluently and flexibly
5. Forming hunches (using intuition and hypothetical thinking)
6. Designing tests and experimenting
7. Searching for patterns
8. Using models and metaphors
9. Finding elegant solutions (combining richness and simplicity)

Affective habits of mind:
1. Risk taking
2. Cooperating and collaborating
3. Competing (vying with oneself to reach for excellence)
4. Perseverance and self-discipline

Such traits are coveted for any classroom teacher, let alone a productive citizen in society. Sizer (1992) notes that one who possesses this frame of mind exhibits more than mere skill. An individual with such habits of mind also has motivation, or a “disposition” congruent with using these abilities. Many people have particular talents or skills, but fail to use them in a productive or wise manner. “Having the skills today is but a small part of the whole. Being committed to using them consistently tomorrow is the crux of it” (Sizer, 1992, p. 74). Successful application relies on effective education and preparation.
Indeed, mastery of such concepts and skills is vital to productively function as an educator. These habits must be readily available at a moment’s notice and feature accurate implementation:

Teaching more than virtually any activity (aside from parenting, perhaps) depends on quick instinctive habits and behavior, and on deeply held ways of seeing and valuing. When a child asks if he can have another cookie, go to the bathroom, sharpen his pencil, move his seat, or stay indoors at recess, [the teacher’s] answer carries with it a host of assumptions about what is and is not appropriate and why. Correcting a child’s writing, calling on children who don’t have their hands raised, complimenting a child on his or her clothing, deciding whether to intervene in a quarrel, pretending not to overhear a cruel tease—all carry messages of import, and all involve decisions that must be made instantaneously. (Meier, 2002, p. 139)

An interesting dichotomy exists in the classroom. Teachers must make immediate decisions and take instant action, but at the same time always consider and reflect on the long-term effects and goals for students. Education is not likely to succeed through free spontaneity. Teachers cannot “wing it,” but actually must enter the classroom with extensive preparation and planning, more so than one who simply lectures. This method requires a sound structure of understanding and ability within and among each teacher. As Dewey argues, such an informed (i.e. “scientific”) approach to education is not binding, but rather freeing. “Command of scientific methods and systematized subject-matter liberates individuals; it enables them to see new problems, devise new procedures, and, in general, makes for diversification rather than for set uniformity” (1929, p. 12). Having such a capacity is crucial for effectively teaching in the dynamic classroom domain.

**Developing the Habits**

In his description of an idealized school system, Sizer (1992) discusses attitudes toward habits of thoughtfulness: “Ultimately, it is people’s habits we most value and respect. Schools must embrace this commonplace, and organize themselves to nurture good habits”
Though Sizer is speaking specifically to secondary schools, the same habit-developing setting is necessary for teacher-preparation. What is valued in students must also be present and promoted in teachers. Meier (2002) cites habits of mind as a central requisite of teacher education. She argues that effective teacher preparation requires transformation in three areas: (1) changing one’s view of learning; (2) developing new habits of mind to go with this new cognitive understanding; and (3) simultaneously developing new “habits of work”—habits that are collegial and public in nature, not solo and private as has been the custom in teaching” (p. 140). The first ingredient—modifying views of learning—connects to conceptual change of individuals’ notions of learning and teaching. Discussed elsewhere in this paper, examining and transforming ideas create a foundation from which to build. The latter two elements—forming and using habits—connect to direct application and practice in the classroom. One must examine with close scrutiny, therefore, the ways and means to develop these habits in teachers.

Sizer (1992) offers his answer to this query by addressing the origin of a habit. Although not comprehensive, the following description provides insight into conscious and subconscious changes that preservice teachers experience.

Habit grows from a mixture of conviction (“This is good for me; it is persuasive; I can use this to good advantage”), of practice (“I can do this stuff in my sleep”), and of reinforcement from the community (“The place where I live and study is a place that values this”). (p. 69)

Successful teacher education creates permanent, positive change in teachers’ understandings, skills, and daily actions. Yet this transformation—like effective classroom instruction—does not simply occur spontaneously. Some advancement may transpire as one develops mentally and biologically; however, “it does not occur incidentally or as the result of maturation
alone” (Kassem, 2005, p. 21). The process of successfully cultivating habits of mind requires several key components.

Just as people must have motivation to go through conceptual change (Pintrich, Marx, & Boyle, 1993), they must also possess a desire to develop these habits of mind. “People’s habits change only when they have strong reasons to want to change, and a conducive environment” (Meier, 2002, p. 149). Postman’s writings (e.g. Postman & Weingartner, 1969), Goodlad’s school studies (1983, 1984), and other research of teacher preparation (Darling-Hammond, 1999; Munby & Russell, 1993; Olson, 2007), though, indicate that most teachers have an educational background counter to many valued academic habits of mind. A disproportional amount of teachers may even prefer the unintuitive, reactive, passive demeanor that typifies the current schooling atmosphere. The transformation process preservice teachers experience can certainly be overwhelming. Therefore, if teacher preparation is to succeed, it must address motivational needs of the preservice teachers. No change in habits will occur unless it is accompanied by a fervent desire. Instructors must provide adequate assistance and encouragement for students to give the required effort for this arduous transformation.

More than mere support, teacher educators must also teach. The climate of education, content, or methods courses favorable for habit-forming includes instructors who continually model habits of mind required of future teachers. Teacher educators themselves must exhibit attentiveness, appropriate questioning and feedback, focus, collaboration and communication skills, and other habits. The instructor shows how an understanding and mastery of key habits are essential. They afford the teacher innumerable advantages in promoting successful learning, providing stability in capricious classrooms.
Husu’s discussion of Aristotle’s *phronesis* includes an acknowledgement that such logic-in-action is particularly difficult to teach (2002). Therefore, such habits of mind—often implicitly harnessed—must be explicitly addressed in teacher education courses. Modeling is not sufficient. The instructor must explicitly draw out and discuss these habits. It must be a continual component of the methods classroom. “For example, the instructor might explain the reasons for instructional design decisions and ask for student feedback regarding those decisions, thus modeling reflective habits of mind and openness to the views of others” (Kassem, 2005, p. 13). Furthermore, the teacher educator is transparent in his or her classroom choices and actions, calling students’ attention to these purposeful behaviors that frequently remain unnoticed.

Such habits of effective teachers are developed through “a conscious process of enculturation” (Freidus, 2000, p. 4, citing Putnam & Borko, 2000). More than simply behaviorist means, though, the understanding and skills take shape through active reflection. Reflective thought is a vital step in the process of learning, developing, and employing appropriate habits of mind. With references to Dewey, Freidus (2000) discusses the “discourse community” in which preservice teachers develop these habits:

Learning . . . is a process of social-construction. It is the outcome of enculturation into a community’s habits of mind and ways of acting and interacting as much—if not more than—the result of direct instruction of specific skills, concepts and attitudes. However, the process is not purely assimilationist. Each individual experiences the process of enculturation through a unique set of experiences which in turn builds on his or her own set of prior knowledge and experiences. (p. 3)

Reflection is a synergetic fit with learning other habits of mind, as these skills and understandings facilitate a reflective perspective. “Models of thinking can provide a framework within which reflection can be coherent, productive, and growth enhancing. Such
a framework takes the reflection to deeper, richer levels” (Cook, 1996, p. 50). Teacher educators, then, must create conditions that evoke and enable preservice teachers to use reflection.

These situations... should be those lived by teachers. Teachers can experience the situations, real or contrived, and can then be encouraged to give those situations careful, thoughtful consideration with an eye to increasing their understanding of the phenomenon of teaching and themselves as teachers. Rather than behaving purely according to impulse, tradition, and authority, teachers can be reflective—they can deliberate on their actions with openmindedness, wholeheartedness, and intellectual responsibility. (Cruickshank, 1987, p. 7)

Such social, context-specific learning and teaching experiences are echoes of problem-based learning first developed by Dewey (1916, 1933; see also Mayhew & Edwards, 1936). Future teachers develop their habits of mind as they reflect on authentic instructional occasions, including their own.

Faced with the particulars of a teaching experience, the student of teaching is asked to draw conclusions... what happened in general? Did learning take place? What happened to promote learning? What happened that got in the way of learning? What did the pupils actually learn? What might they have learned? What other ways might the material have been taught? What is the role of the teacher? (Holton, 1984, p. 8)

Each question holds significance to forming teachers who are competent in curriculum and instruction. Additionally, individuals can benefit by examining habits and frames of reference exhibited by others.

An awareness of the habits of mind used by all the great thinkers can expand the aims and goals of teacher and supervisor alike in planning and implementing learning and can legitimize and honor those ways of thinking that are used by teachers and learners. (Cook, 1996, p. 50)

Meanwhile, preservice teachers gain insight by considering successes and failures of the past, including reasons for such results. Historical models prepare teachers for forming better futures, as “the confidence to grasp the new depends on mastery of the old” (Sizer, 1992,
Throughout all of these experiences, preservice teachers are called to reflect. Conscious, cognitive deliberation of classroom choices occurs, featuring more than simple opinion or guess. Each decision and action occurs in a specific context with overarching understandings of how people learn, goals for students, and the means to accomplish learning objectives.

Motivation, explication, reflection are all necessary ingredients of habits of mind development. However, one factor remains to ensure the success of this delectable spread. These habits of mind need sufficient time to mature. One cannot rush teachers into developing and mastering habits of mind necessary for immediate retrieval and application in the classroom. This cultivation requires academic gardening, pruning, and fertilizing. Leadership skills—one element of effective habits of mind—are equally slow to develop. Nevertheless, gradually blooming traits are often more durable, permanently fixed with deep-seated roots (Gardner, 1995). Other research studies have found that programs must be time-intensive—learning multiple days of the week for subsequent months, even years—to yield improved performance (Feuerstein, 1980; Pogrow, 1988; cited in Kassem, 2005). Meier (2002) elaborates on the chronological component:

[Teachers] need time. They need time in a daily, weekly, monthly sense—to reflect, examine, redo. They also need the other kind of time—the years it will take to see it through. These are the conditions that paradoxically apply whenever we’re in a hurry to do something difficult: cure cancer, go to the moon, invent new technologies. (p. 150)

Teaching is difficult. An implication from the foregoing is that graduates from a teacher preparation program requiring multiple semesters of teaching methods courses would have a higher match to the habits promoted, modeled, and advocated in those classes. Having these classes meet on a consistent basis might add to the effectiveness of developing appropriate
habits in preservice teachers. Without such exposure and attention to learning, preservice teachers might be less likely to develop skills and understandings that align with their preparation program.

The challenge of learning and developing habits of mind is as monumental as the task of teaching and assessing them. Kassem (2005) describes the undertaking as “controversial and complex” (p. 21). Like other instructional experiences, one must beware of simplifying content to the point of insularity (Freidus, 2000). Habits of mind are not tricks. They are complex concepts and capacities that enable a teacher to excel in a multifarious milieu. No one can precisely predict every occurrence in a classroom. Yet the development of habits creates a framework from which teachers can face and flourish among classroom challenges. Successful schools—for preschool or preservice teachers—strive to instill habits in their students. Sizer (1992) describes the shortcomings of schools that disregard promotion of healthy habits: “Not being clear about these habits leads to mindlessness, to institutions that drift along doing what they do simply because they have always done it that way. Such places are full of silly compromises, of practices that boggle commonsense analysis” (p. 74). This description evokes familiar images of stumbling teacher preparation institutions found in numerous studies and encounters. Such ineptitude need not be the case.

Teacher education and teacher educators alike must develop cognitive and affective habits of mind. Only then can they help future teachers form these understandings and abilities. The process takes time, desire, examples, and thought. It is difficult, but it is worthwhile. Habits of mind ultimately prove advantageous in the daily workings of the classroom. When achieved, such traits may even appear effortless (Feiman-Nemser & Floden, 1986; Munby, Russell, & Martin, 2001). But this view is not accurate, and teachers
must not be fooled into believing they can rely on style, personality, or spontaneity alone. The master craftsman understands not only what works, but how, why, where, and when. Cook (1996) claims that such a deep discernment directs teachers to improve and invent instructional “tools.” To have lasting impact, teachers must learn the fundamental rationale and reasons for their actions and choices. This “mixture of awareness and logic” is what Sizer calls the “residue of serious learning” (1992, p. 72). It is a remnant that lasts and grows over time, emerging even stronger after the early struggling years of teaching (Grossman & Valencia, 2000). Teachers not only survive, but also surpass educational expectations. With healthy habits of mind, they possess the power to infuse positive pedagogical change. Such a framework fosters proactive—not reactive—teachers. Dewey promoted this notion nearly a century ago, identifying teachers’ potential to solve problems in a transforming society. This capability comes from a collection of habits—active and engaged traits, as opposed to mere customs:

The essence of a habit is an acquired predisposition to ways or modes of response. . . . Habit means special sensitiveness or accessibility to certain classes of stimuli, standing predilections and aversions, rather than the bare recurrence of specific facts. It means will. (Dewey, 1922, p. 42)

But the growth and sustaining process never ends. As Dewey would argue, new problems always arise that need solving among a society of learners (1929). The ability to successfully tackle such issues relies on effective habits of teaching. These are the same traits necessary for learning, the foundation of all education endeavors. “The first object of any act of learning, over and beyond the pleasure it may give, is that is should serve us in the future. Learning should not only take us somewhere; it should allow us later to go further more

**Institutional Constraint**

Regardless of intentions by teachers and teacher educators, effective habits of mind and habits of action never reach fruition in many classrooms. Barriers arise to the development of these skills and understandings. Although many school, community, and personal attributes determine a teacher’s level of mastery, one’s own institution has emerged as an agent of possible constraint.

**Elements of Institutional Constraint**

Upon any examination of a dynamic entity such as a school, one will find several stakeholders with diverse objectives and influences (Spector, Greely, & Kingsley, 2004). These stakeholders include school faculty and staff such as teachers, principals, and superintendents, as well as students, parents, and community citizens. Each party approaches education and schooling from a different perspective. Each has its own priorities and expectations. Consideration of stakeholders’ stances and support is critical in predicting success of educational reform efforts. Moreover, teachers and administrators will affect reform outcomes by the degree of their actions toward these goals (Berman & McLaughlin, 1975; Cuban, 1984; Tyack, 1990).

Stakeholders’ views of constraint have been found to depend on personality types and perceptions of school climate (Pinnell, 1990). Despite viewing education from different perspectives, those with direct contact with students—teachers and principals—both show agreement about barriers to effective education (Desimone, 2006). Desimone’s survey of teachers, principals, and districts about educational policy reports commonly cited barriers:
resistant students in the school, insufficient materials and resources (textbooks, technology, guidance, and professional development), and inappropriate standards. The reauthorized No Child Left Behind Act (Hoff, 2007) is the primary mandate with stress-induced standards. A study of NCLB reveals that constraint on teacher decisions is one product of the act (CEP, 2006). Negative effects include schools that are “more prescriptive about what and how teachers are supposed to teach” and “squelching creativity in teaching and learning” (CEP, 2006; cited in Rebora, 2006, p. 1). Such compelling pressures by standards and tests are not limited to teachers in the United States (Monk, Swain, Ghrist, & Riddle, 2002). Adding to the burden is the influx of parents scrutinizing their students’ test scores and demanding teacher accountability (Bishop & Nickson, 1983; Orrill & Anthony, 2003; Reys, Reys, Barnes, Beem, & Papick, 1998).

Literature and media frequently direct their attention to classroom teachers when examining barriers to educational reform and effective teaching (Day, Elliot, & Kington, 2005; Goodson, Moore, & Hargreaves, 2006; Kelchtermans, 2005; Shulman, 2004; Welner, 1999; Zimmerman, 2006). The interconnected issues of teacher quality and education reform become further confounded by national debates regarding merit or performance pay, district finance distribution, and teacher credentials (Moses, 2007; Smith, 2007). Nevertheless, teachers still often find themselves in the middle of the battle against barriers to educational reform. Orrill and Anthony (2003) posit that constraints on teachers may vary according to the degrees of perception and reality. “Real” barriers include those that are physically evident such as a lack of materials, parental involvement, and support for standards. Perceived barriers are more difficult to ascertain, such as the “newness factor” and time necessary for implementing reform-based curriculum as well as mastering pedagogical
approaches. Whether the constraints are concrete or abstract, Orrill and Anthony do argue that “all of these may be seen as ‘real’ barriers” for classroom teachers (p. 12, 2003).

In her review of literature about teachers and change, Meister (2000) compiles a summary of recurring barriers experienced by teachers attempting lasting reform. These constraints appear in additional research on teacher change. In any occurrence of change, a degree of uncertainty exists, involving “learning, anxiety, difficulties, and fear of the unknown” (Fullan, 1993, p. 25). Change with teachers garners further uncertainty due to the convoluted nature of educating a diverse population of students. Along with this ambiguity is the question of how much control a teacher has over his or her profession. Decisions made for the teacher by outside forces yield feelings of isolation and incapacitation (Barth, 1990).

Like uncertainty, time allotted for change has unique influence in the domain of schools. The typical classroom contains a distinctive temporal atmosphere. Teachers feel a “time crunch” in dealing with students, achieving learning objectives, and addressing administrative and managerial tasks (Fullan, 1991). The school day’s incessant sense of urgency is noteworthy when considering time is the primary ingredient needed for lasting innovation (Corbett, Dawson, & Firestone, 1984). The result of intensification is frustrated and guilt-ridden teachers (Werner, 1988; cited in Hargreaves, 1994). Studies into professional development implementation indicate similar effects: “Most [teachers] still felt isolated in their building rather than as part of a grade-level team. Many said it was because of a lack of time; others thought it was because they were ‘waiting for someone to take the initiative to get us talking with each other’” (Bainer & Wright, 1998, p. 5).

Intensified time and isolation are constraints that yield another: conflict. Any successful change must occur with some essence of conflict (Fullan, 1993). However, if not
handled deftly, conflict can hinder intended reform. Compare the following statements with
the typical school setting: “The conflict arises when people have different ways to
implement the vision. This conflict can be destructive if it reinforces hierarchy and silences
participants by imposing one narrow standard of behavior on all participants” (Meister, 2000,
p. 9, citing Gitlin et al., 1993). The culture of school itself encumbers teachers’ reform
efforts. Often one principal or colleague can hinder the growth of a teacher (Page & Page,
1994). Top-down mandates from a district, administrative, or department office add stress to
an already demanding profession. Inundated teachers may quickly develop methods to resist,
defer, or rework such demands.

Teachers have a built-in resistance to change because they believe that their work
environment has never permitted them to show what they can really do. Many
proposals for change strike them as frivolous—they do not address issues of
boundedness, psychic rewards, time scheduling, student disruption, interpersonal
support, and so forth. (Lortie, 1975, p. 235)

The above description adds credibility to those who blame teachers for unsuccessful reform.
While the cause is debatable, the intent of teachers’ actions is apparent. Their behavior is a
matter of survival. External forces have put teachers into a fight-or-flight mentality.

Forces that pigeonhole teachers’ progress originate from multiple sources. Federal
bureaucracies and state legislatures are commonly recognized culprits (Duttweiler, 1988;
McElrath, 1988). Outside pressures can even arrive from down the hallway. Principals
perceived as critical or punitive will have a school full of risk-avoiding teachers (Lieberman
& Miller, 1984). Classrooms will remain stagnant, yet safe, as teachers hunker down for
protection against “Big Brother.” Another external force is professional development, which
Meister (2000) describes as follows: “In this model, staff development means workshops
conducted by outsiders with little or no change evident in practice. Typically these
workshops contain little interaction among participants and become simple attempts at group growth” (p. 18). Again, the barriers of limited time, isolation, intensification, and conflict all emerge. Teachers recognize such external barriers and perceived exemplars. In a survey of 151 teachers in educational leadership graduate programs, respondents cite outside forces as the predominate barrier to reform (Lovette, Savoie, & Armenta, 1998). Eight out of the top ten barriers identified were external issues. Examples are dysfunctional families, moral and ethical decay of society, student attitudes toward education/unmotivated students, problems at home, and parental support. As this survey study indicates, students themselves are a constraint faced by teachers when implanting effective instruction. Other studies of reform efforts also find student attitudes and responses as barriers (Bishop & Nickson, 1983; Byrd & Doherty, 1993; Desimone, 2006; Kahle & Rogg, 1998; Reys et al., 1998). When trying new pedagogy in the classroom, the teacher appears foreign compared to students’ previous and current schooling experiences. Students may not understand or accept the roles of the teacher and themselves. As a result, Byrd and Doherty (1993) report student frustration and diverse reactions, including “lethargy, rebellion, resistance, and/or confusion” (p. 13).

Students’ reactions to change are parallel to those of their teachers. A sense of top-down directive exists on both levels. Teachers have the added task of educating—or rather, re-educating—students on the notion of schooling and learning. Even worse, teachers are stuck in the middle, facing restraint from both students and institutions. And external forces from bureaucratic avenues continue to press. Nevertheless, one must resist the urge to discount efforts from such groups. The intent may indeed be noble. The execution, though, may be misguided. “Many of our present and past efforts to reform education and improve the academic performance of students could be likened to applying a Band-Aid to a big toe to
cure lung cancer” (Lovette, Savoie, & Armenta, 1998, p. 6). Reform efforts must work smarter, not harder. Teachers are the primary ingredient to successful education (Berliner, 1989; Cremin, 1961; Duffee & Aikenhead, 1992; Fullan, 1991; Good & Brophy, 1994; Goodlad, 1990c; Penick, Yager, & Bonnstetter, 1986; Sanders & Rivers, 1996; Shymansky & Penick, 1981). Schools and society must look to teachers’ expertise and direct influence for the solution. The result of ennobling and hearkening teachers is exponential. Doing so will not only enhance educational reform, but also reduce institutional constraints.

**Loosening the Restraint**

Meister (2000) provides recommendations for decreasing these barriers to teachers and change. One step in overcoming institutional constraint is to address issues as a group. Members at each level of power must have a voice and impact in change. “Without full participation of stakeholders and establishing a systems view, role ambiguity and conflict will continue to be a pervasive problem in education” (Isaacs, Greene, & Valesky, 1995, p. 12). Stakeholders include teachers, administrators, legislators, parents, students, and more. “Only by being true to the full growth of all the individuals who make it up, can society by any chance be true to itself” (Dewey, 1907; cited in Isaacs, Greene, & Valesky, 1995, p. 4). As a cornerstone of society, schools must be at the forefront of inclusion.

A shared vision among the ‘voices’ is essential. Only by negotiating this vision with all associated individuals (teacher, students, parents, administration, [academies], and colleagues) will the teacher be able to facilitate change. This process will ensure that all those involved have a stake in the outcome. (Byrd & Doherty, 1993)

Such collaboration in reform is especially necessary as the change process transverses the momentary “implementation dip” (Fullan, 1991) before showing signs of improvement.
Although the initial implementation stages face just a “dip,” the entire change process still takes time. Available hours, days, months, and more have additional importance in the particularly time-pressured profession of teaching. Sufficient time affords freedom and flexibility to truly develop understandings and skills necessary for successful educational reform. For example, Bainer and Wright’s 1998 study of professional development indicates that teachers need at least one year of learning, practice, and reflection to implement meaningful change.

Lasting improvements require focused efforts. However, a delicate balance is necessary for growth. Intensification must promote reform without overloading teachers. As addressed earlier, a similar equilibrium exists for the role of conflict. Glickman (1993) calls for schools to engage in “public conflict” in order to create change in which all stakeholders have some control:

Public conflict indicates that an issue is important, that people see themselves as having a real influence on decisions, and that information about possible options and consequences is multiplying. The absence of public conflict in school change can be a danger sign. It can indicate that people do not care, do not believe that there is any merit in making their views known, and prefer to go along with whatever the most dominant persons have to say. (p. 92)

Note that such “dominant persons” in a school system are not necessarily correct in their diagnoses and prescriptions for improvement. Unfortunately, many teachers will experience institutional constraint due to any number of domineering individuals inside and outside the school building. Bainer and Wright (1998) address concerns about conflict and control in implementing reform:

The climate requires that teachers are provided with a variety of options to reach and demonstrate the learning objectives or professional development. By thoughtfully developing individual plans based on a personal assessment of their professional
needs, developmental level, and cognitive approach, teachers are able to maximize professional development. (p. 7)

One must first be equipped with an understanding and expertise to effectively assess, design, and implement within this context.

Interestingly, criteria for diminishing institutional constraint have extensive overlap with ingredients needed for developing effective habits of mind in teachers and learners. Intensification of efforts requires motivation. Group interactions afford conscious, explicit articulation of favored outcomes. Reflection and discourse enhance the notion of “public conflict.” Finally, both discussions consider the powerful role of time. The promotion of habits of mind, therefore, is a significant strategy for lowering institutional constraints and preparing teachers to successfully function when such barriers arise.

Two case studies of individual teachers reveal firsthand experiences with institutional constraint. Although teaching is a highly context-specific profession, these two teachers’ experiences are a microcosm of such conditions. Byrd and Doherty (1993) studied “Eric,” a 35 year-old and 9-year veteran science teacher attempting to incorporate inquiry-oriented instruction. Eric experienced “tangible” constraints in the form of physical requirements such as money and materials; mixed messages from colleagues, administrators, parents, and students; personal issues such as time demands and role transformation; and finally frustrated and resentful students. Eric had worked through many more fluctuations during his change process than expected. By the end of the study’s first year, Eric did not reach his anticipated level of change. A second case study (Page & Page, 1994) followed “Connie,” a high school biology teacher in her late 20s and with nearly a decade of full-time teaching experience. Connie also experienced barriers, notably reform adoption without appropriate teacher
preparation and superficial school restructuring without deeper cultural change. Nevertheless, over the course of three years, Connie’s own efforts created transformations in curriculum, instruction, and administration throughout her school district. Page and Page (1994) identify Connie’s personal attributes and efforts to be key ingredients in overcoming institutional constraint. These qualities include mastery of instructional and institutional competencies, and personal vision building that culminated in shared vision with her colleagues. “Connie always had a sense of moral purpose in education” (p. 8), and described herself as wanting to make a difference in the classroom. Such a personal passion for teaching students is perhaps another component necessary for overcoming institutional constraint.

The studies of Connie and Eric are diverse and feature teachers from different programs, backgrounds, school settings, and more. The notion of a teacher’s passion to make change, though, is a curious topic for future study. What role does personal devotion have in teacher quality? How does teacher competency relate to a teacher’s moral purpose and dedication? To what extent can a teacher preparation program promote these traits in addition to other desired outcomes?

**Basis for the Present Study**

The present study focuses on the habits of mind and educational goals teachers exhibit in their classrooms and compares them to those promoted in their preservice preparation program at Iowa State University. This study is limited by its investigation of one secondary science teacher education program. However, analysis of the changes to ISU SSTEP and the effects on its graduates may be extrapolated to inform other institutions seeking to increase the alignment of their graduates with the preservice teacher program.
Science education and teacher preparation are struggling to find lasting improvement. Reform efforts need not be massive for teacher educators to enhance their programs. Moreover, research into one program can afford valuable insight into the impact of one program’s changes on its graduates. The habits of mind (understanding, action, reflection, improving practice) and educational goals promoted, modeled, and advocated in ISU SSTEP—along with its program changes—may have drastic influence in graduates’ professional practice and academic thought. The extent to which these teachers match ISU SSTEP research-based framework indicates the true impact of the program. Through examination of this “self-audit,” teacher educators can reflect on their own programs, the goals and habits promoted, and the subsequent impact on graduates. Only through such efforts will teacher education have lasting influence on future teachers and the future of American education.
CHAPTER 3: RESEARCH METHODS

Summary of Study Purpose

Medical schools were not always so highly respected in the nation. These institutions were once in the same state of assorted effectiveness now exhibited by teacher preparation programs. As medical education transformed following the Flexner Report in 1910, so too do teacher education programs require such an investigation to trigger monumental change. Considerations must be made, of course, to align to the unique nature of teacher education (Goodlad, 1990c). A persistent problem in teacher education is the powerful influence that the culture of the school and experience exerts on teachers’ practices (Featherstone, Gregorich, Niesz, & Young, 1995; Feiman-Nemser & Buchmann, 1985), raising the issue of whether or not teacher education has any impact at all. Zeichner and Tabachnik (1981) aptly summarized this situation in the title of their article on this subject: “Are the effects of teacher education ‘washed out’ by school experience?” Not surprisingly, such concerns have led authors of commissioned governmental reports to advocate strong content knowledge and a few weeks, if any, of formal experiences in teacher education (U.S. Department of Education, 2002).

Such attacks on teacher education programs fail to recognize that teacher education program structures differ widely, and may have markedly different impacts on teacher effectiveness in the classroom. The present study seeks to determine how two science teacher education program structures impact the understandings and practices of its graduates, determined by observing the goals these teachers promote and the program-designated habits of mind they exhibit. While this study does not consider student achievement (due to time and resource limitations), it does examine key issues such as
teacher behaviors, pedagogical knowledge, and their relationships with teachers’ preservice preparation—issues that have been neglected in past research (Wilson, Floden, & Ferrini-Mundy, 2001). In addition, this study recognizes that what the teacher does in the classroom is considered the single most influential classroom-based factor that affects student achievement (Berliner, 1989; Cremin, 1961; Duffee & Aikenhead, 1992; Fullan, 1991; Good & Brophy, 1994; Goodlad, 1990c; Penick, Yager, & Bonnstetter, 1986; Sanders & Rivers, 1996; Shymansky & Penick, 1981). Following Windschitl’s recommendations (2005) for improving research into science teacher education, this study develops a clearer picture of important teacher education program components (time and intensity of program, content and skills taught, behaviors modeled and promoted by science methods faculty, habits advocated by same faculty, etc.) and their impact on teacher performance. Collected evidence—as recommended by Craven and Penick (2001)—includes feedback from recent SSTEP graduates such as self-perceptions, school-based performance indicators from these teachers, and performances used in portfolio evaluations such as classroom materials, assessments, lesson plans, and records of video- or audiotaping.

This study examined ten science teachers with respect to how well their professional practice and understanding matched what was taught in their preservice preparation program. Five teachers came from the program’s current format, which includes three sequential semesters of science teaching methods. The other five teachers came from the program’s former format, which featured only one semester of science teaching methods. While generalization to other institutions is limited due to the small sample size in this study, elements of the program that appear to have a strong impact on these graduates should be studied on a broader scale and potentially considered important if science teacher education
programs are to have an impact greater than that reported elsewhere in the literature (USDE, 2002). Research reported and discussed here is intended to provide insight and information to guide further research with the ultimate goal of equipping teacher education institutions to make appropriate decisions regarding their programs.

**Review of Research Questions**

Research questions guiding this study concentrate on two components of teachers’ professional practice:

1. **Educational Goals for ISU SSTEP Graduates’ Students:**
   a. What do graduates of the former and current ISU SSTEP report are their goals for students?
   b. What do secondary students in the classes taught by former and current ISU SSTEP graduates perceive are the goals promoted in the class?
   c. In classroom observations of former and current ISU SSTEP graduates, what goals appear to be promoted?
   d. How do these results compare to the science education goals modeled, promoted, and advocated by ISU SSTEP faculty?

2. **Habits of Mind of ISU SSTEP Graduates:**
   a. What habits of mind—understanding, action, reflection, improving practice—do former and current ISU SSTEP graduates exhibit?
   b. How do these compare to the habits promoted and modeled in ISU SSTEP?

These research questions do not address the connection between ISU SSTEP’s impact on teachers and its impact on 7-12 students’ science achievement. The study seeks to understand how well ISU SSTEP produces teachers that exhibit the behaviors and understandings modeled and promoted in the program. Moreover, it intends to compare teachers from the two groups in terms of their educational goals for students and their habits of mind in planning, teaching, and evaluating science instruction. Data collected and analyzed for topic one questions also help answer the broader questions of topic two. The
following sections provide further information about the study participants and the design of the study.

**Participants**

Since the year 2000, over 120 individuals have graduated from the ISU SSTEP. As the years progressed, different components were added to the science education program. Changes include additional classes (a sequence of multiple science teaching methods courses, the nature of science and methods to teach NOS), extended time span of meeting, and a Master of Arts in Teaching (MAT) alternative certification program for qualified individuals with an undergraduate degree in a science field. A description of the program providing further information about these changes and the program in general can be found in Chapter 4.

Ten teachers participated in the study. Five graduated from the former structure of the ISU SSTEP (designated Teachers F-1 through F-5); the other five graduated from the current format of ISU SSTEP (Teachers C-1 through C-5). A feature of the program that strengthens conclusions drawn from this study is that the science teaching methods courses had the same professor as instructor of the science methods course(s). This is a noteworthy controlling variable when comparing graduates from different years and programs.

All participants taught science at the secondary level (6-12) in either a public middle school or high school in central Iowa. Eight of the ten graduates were male; all were Caucasian, between 24 and 43 years of age, most in their mid- to late-20s. As teachers from the current program were usually more recent graduates, they typically had fewer years of teaching experience than those from the former program. This difference in groups’ relative
experience will be addressed in Limitations below and Chapter 5. Table 1 provides an overview of study participants.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Years of Experience</th>
<th>Age</th>
<th>Sex</th>
<th>Teaching Position</th>
<th>Location (Iowa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-1</td>
<td>4</td>
<td>26</td>
<td>F</td>
<td>7\textsuperscript{th} Grade General Science 7\textsuperscript{th} Grade Social Studies</td>
<td>Suburban</td>
</tr>
<tr>
<td>F-2</td>
<td>6</td>
<td>33</td>
<td>M</td>
<td>10\textsuperscript{th} Grade Biology 11,12\textsuperscript{th} Grade Anatomy &amp; Physiology</td>
<td>Rural</td>
</tr>
<tr>
<td>F-3</td>
<td>4</td>
<td>27</td>
<td>M</td>
<td>11\textsuperscript{th} Grade Chemistry 11,12\textsuperscript{th} Grade Anatomy &amp; Physiology</td>
<td>Suburban</td>
</tr>
<tr>
<td>F-4</td>
<td>5</td>
<td>29</td>
<td>F</td>
<td>10\textsuperscript{th} Grade Biology 11\textsuperscript{th} Grade Chemistry</td>
<td>Suburban</td>
</tr>
<tr>
<td>F-5</td>
<td>1.5</td>
<td>43</td>
<td>M</td>
<td>9\textsuperscript{th} Grade General Science</td>
<td>Suburban</td>
</tr>
<tr>
<td>C-1</td>
<td>3</td>
<td>26</td>
<td>M</td>
<td>10\textsuperscript{th} Grade Biology</td>
<td>Suburban</td>
</tr>
<tr>
<td>C-2</td>
<td>2</td>
<td>26</td>
<td>M</td>
<td>7\textsuperscript{th} &amp; 8\textsuperscript{th} Grade General Science</td>
<td>Urban</td>
</tr>
<tr>
<td>C-3</td>
<td>2</td>
<td>26</td>
<td>M</td>
<td>6\textsuperscript{th} Grade General Science</td>
<td>Urban</td>
</tr>
<tr>
<td>C-4</td>
<td>2</td>
<td>28</td>
<td>M</td>
<td>10\textsuperscript{th} Grade Biology 11\textsuperscript{th} Grade Physics</td>
<td>Suburban</td>
</tr>
<tr>
<td>C-5</td>
<td>1</td>
<td>24</td>
<td>M</td>
<td>9\textsuperscript{th} Grade General Science</td>
<td>Suburban</td>
</tr>
</tbody>
</table>

**Study Design**

The present study is part of a larger research project evaluating the effectiveness of secondary science teacher education program components from one university. The focus is on aspects of the program itself that are evidenced in graduates’ practices beyond student teaching and into the induction years. The evolving nature of the program under study—
adding, supplementing, and expanding coursework—affords an examination of dependent
effects of modifications. To attend to the weaknesses of previous small-scale investigations,
the present study endeavored to align itself with Windschitl’s (2005) criterion for “well-
crafted studies” that employ a systemic view of the teacher education process as modeled by
this singular program.

The goal is to enhance understanding by acquiring thick descriptions analogous to
those developed in Goodlad’s studies. Though not as extensive as Goodlad’s work, the
present use of thick, rich descriptions promotes external validity, or generalizability
(Merriam, 2002) in the qualitative case study element. A vivid, specific narrative of each
participant and the program prompts readers to make comparisons to their particular
circumstances. “In case study research, data analysis consists of making a detailed
description of the case and its context” (Hébert & Beardsley, 2002, p. 209). Reported in this
study are thorough portrayals of the teaching participants, including their current and past
teaching experiences. In its discussion of results and findings, Chapter 4 describes the
framework of ISU SSTEP.

**Recruitment**

Participants were selected from the 120+ graduates from ISU SSTEP since 2000.
Criteria for selection included proximity for convenience of travel, an equal number of
former and current program graduates, an equivalent range of school size and grade levels,
and an equivalent range of graduates’ performance in the ISU SSTEP program as determined
by the ISU SSTEP science teaching methods instructor. All participants were contacted via
email and a letter that described the study and asked for their voluntary participation.

Teachers chose appropriate days for researcher visits, based on schedules and lessons that
typified their instruction and interactions with students (avoiding test and video days, for example). All participants signed an informed letter of consent (*Appendix A*). Additionally, building principals signed a letter of consent for the researcher to visit the school as part of the study.

**Data Collection**

The primary goal of this study is to understand the effects of two preservice science teacher preparation program structures on teachers’ decision-making and teaching practices in the classroom. As Cremin (1961) notes, “the ultimate proof of an education is in the lives people lead when they have left the classroom” (p. 255). This study investigated the lives, attitudes and behaviors of program graduates who have left the college classroom and now teach on their own. A naturalistic inquiry approach (Harry, Sturgis, & Klinger, 2005; Norris & Walker, 2005; Thompson, 2003) was used and data sources came from four main categories: (1) classroom observations, (2) student questionnaires about educational goals, (3) teacher interviews and on-line questionnaires, and (4) classroom artifacts.

**Classroom Observations**

The researcher observed classroom lessons of each participant currently teaching. Three classroom lessons were observed for each teacher, with the exception of Teacher F-4, who had to take a medical leave of absence from teaching during the study and was observed once before leaving. The rationale for observing teachers was that their current behaviors indicate the extent to which ISU SSTEP effectively promoted and developed the intended goals for its graduates. “Effective teaching behavior influences or adds value to PK-12 student learning. Effective teacher education yields teachers who behave in ways that influence or add value to student learning” (McNergney & Imig, 2006, p. 4). For most
teachers, the researcher observed two of the lessons in succession, for example the first and second observations being one day after the other. Consecutive observations were made to afford the researcher an opportunity to observe how the teachers organize the lesson sequence and make decisions that carry across lessons. When such observations were not possible, the researcher asked the teacher to describe their projected lesson sequence for the next day. During observations, the researcher recorded written field notes about general lesson characteristics, occurrences, instructional behaviors, and classroom interactions.

Following each observation, the researcher used three instruments to aid in data reduction and to be used in conjunction with observation notes. The two approaches complement one another, providing insight not readily available through just one technique.

The issue is how we can use [combined methods] to highlight the taken-for-granted practices and perspectives of each approach and how, taken together, they can provide a more textured and productive view of the social phenomena we seek to understand. (Moss, 1996, p. 22, cited in Krathwohl, 1998, p. 618)

Using the “binocular vision” (Reichardt & Rallis, 1994) of both instrument-based categories as well as narrative-based qualitative elements during observations, the present study was crafted to develop a comprehensive understanding of program elements that are detectable in teachers’ practices and explicit conversation. The instruments included three classroom observation coding tools. All three coding tools are found in Appendix B.

**Local Systemic Change (LSC) Classroom Observation Protocol (COP):** The Local Systemic Change (LSC) Classroom Observation Protocol (COP) is an observation coding tool that addresses lesson design, implementation, science content, and classroom culture (Banilower, 2005; HRI, 2006). The ratings (1-5) are determined with respect to reform-oriented science teaching, evidenced by alignment with the National Science Education
Standards, or NSES (NRC, 1996). An overall capsule rating (with a scale of eight possible ratings) is also given for the observed lesson. This capsule rating is not a summative or average of the four categories, but rather based on the overall effectiveness of the lesson, as determined by the observer using a set of criteria. A central consideration in the capsule rating is the level of mental engagement of the students with meaningful and appropriate science content in a way that helps them make important connections and further their understanding. The low extreme of the capsule rating reflects lessons that consist solely of teacher talk with no evidence of student involvement, or “activitymania”—an activity done for the sake of the activity with little or no conceptual development present. The high extreme of the capsule rating reflects lessons that make apparent student thinking, engage students with meaningful and appropriate science content, have a supportive classroom culture where students are comfortable putting ideas forward, and have a high likelihood of improving student learning.

The researcher completed a training session on this instrument in order to establish a high level (>0.85 on each category) of intercoder agreement. This training session was conducted with a faculty member who has completed training on this instrument with Horizons Research Inc., the developer of the instrument. Training involved viewing videos of classroom science lessons and comparing ratings by the researcher and the trainer until there was an agreement of ratings 85% of the time or higher. This instrument is widely used in science education research studies, and was a required part of the evaluation components of all Local Systemic Change grants awarded by the National Science Foundation between 1998-2004.
**SATIC:** A second instrument—the Schlitt Abraham Test of Interaction Coefficients (SATIC)—monitors teachers’ verbal interactions and patterns during classroom instruction by recording the occurrences of various question and response types along with non-verbal behaviors (Abraham & Schlitt, 1973). Graduates from ISU SSTEP received extensive exposure, practice, and training using the SATIC coding tool as a means to analyze their taped lessons and self-monitor their interactions with students, including their use of questions, responses, wait-time, and other teacher behaviors. While the original version of the instrument used totals of each question type and response type and calculated coefficients, students in the program and the researcher in this study used a modified version of this instrument to qualitatively gain a sense of the teacher’s overall interaction pattern with students. This study, like the program under study, explicitly recognizes that no single prescriptive pattern should be evident in every interaction sequence with students. However, to promote long-term goals, certain patterns will tend to predominate (Balzer, Evans, & Blosser, 1973; Blosser, 1975). These patterns include the extensive use of thought-provoking questions followed by wait time and responses that seek elaboration or use students’ responses.

**Emphasis of Educational Goals for Students:** The final coding tool was a list of common educational goals ISU SSTEP preservice teachers develop for their teaching (robust content understanding, problem solving, communication skills, creativity, critical thinking, etc.). A 0-1-2 scale (*Appendix B-3*) was used to summarize the extent to which evidence exists that these goals are promoted in the classroom. Rankings of 0, 1, 2, corresponded with no promotion, moderate promotion, and extensive promotion, respectively.
Student Questionnaire about Educational Goals

A fourth instrument used was a questionnaire completed by the graduates’ current science students. The teacher gave this one-page paper to students as a non-graded handout. Participation was optional and anonymous. The questionnaire, found in Appendix C, asks students to respond on a scale of 1 to 5 regarding the extent to which various goals are emphasized in the classroom. These goals are the same as those used in the goals observation coding tool (Appendix B-3). In both cases, the order of goals in the questionnaire is arbitrary and not in any particular sequence or hierarchy. This student-perspective data approach was modeled after the student questionnaires used in Goodlad’s nationwide study of teachers and schooling (1983, 1984). The consideration of student views afforded discernment into what teachers believe they are promoting and what students actually perceive is being conveyed in the classroom.

Teacher Interviews and Questionnaires

In a previous study, teachers who graduated from this program completed an on-line questionnaire that asked for their comments and rankings (on a scale of 1 to 10) about various aspects of their science education program, their current teaching practices, their future plans and reasons why they might choose to leave the field. The full questionnaire is in Appendix D. For this study, teachers’ responses to questions about general biographical information (current subjects taught, years experience, etc.), student goals they currently emphasize, and the role they believe past ISU SSTEP components play in their teaching practices and planning was used to guide observations and a subsequent semi-structured interview with the study participants. The interview was usually conducted by telephone following observations, with an audio recording made of the interview and with the
participants’ verbal consent. These one-on-one questioning efforts provided clarity to the researcher about the observations and enabled the teacher to provide additional information that could not readily be gained in a busy classroom environment. As Esterberg (2002) describes, “in semi-structured interviews, the goal is to explore a topic more openly and to allow interviewees to express their opinions and ideas in their own words” (p. 87). The interviews were guided by written questions developed in advance, but did not follow a predetermined script or order. Rather, questions followed the flow of the conversation and responses addressed questions as they came up or related to what was said. This less stringent approach allows both the interviewer and interviewee to make—or construct—meaning through the dialogue (Reinharz, 1992).

The initial questions inquired about the teachers’ thinking and decision-making in planning and implementing their classroom lessons. Questions used to guide interviews are in Appendix E. Interviews also addressed questions about the teachers’ lessons, their reflections, and their actions for improving practice. Another item that emerged from the teachers’ interview responses was the issue of institutional constraint. Teachers mentioned barriers to the instruction they wanted to implement, and so more questions were asked to learn more about these experiences and situations. Some additional information from teachers was acquired during informal dialogue before or after observations and via email.

The interviews focused on the participants’ self-reflection and choices, seeking to determine the extent to which they based their decisions on knowledge bases promoted in the program—goals for their students and research on how people learn. In addition, the interview provided insight into the participants’ awareness of their role in the classroom and their conscious choices of strategies, materials, and content to promote learning. A final item
the interviews excavated was the awareness of the teachers toward their current practice and their preferred state. If the teacher was not using effective instruction (as measured through the observations), the interviewer attempted to learn the extent to which the teacher is aware of this gap.

**Classroom Artifacts**

Each teacher shared examples of their classroom materials such as assignments, projects, handouts, assessments, lesson plans, laboratory activities, classroom displays, and more. These materials were shared on a voluntary basis. Most teachers collected copies of their materials as they used them with students and kept a file or box of these documents. Along with all of the above data sources, classroom artifacts provided triangulation in forming case studies and analyses of each teacher.

**Data Analysis**

Conclusions were drawn by triangulation of data sources relevant to each research question. Framed from an epistemology of social constructivism, the qualitative methodology was mostly phenomenological. “The overall purpose [of a phenomenological research methodology] is to understand how people make sense of their lives and their experiences” (Merriam, 2002, p. 38). The elements of interview, observation, document analysis, and informal observation and dialogue afforded the development of case studies for each teacher.

A biographic sketch, or case analysis, of each teacher was developed by triangulating data sources around the questions analyzed in this study about ISU SSTEP graduates’ goals for students and habits of mind. These summaries paint a descriptive picture of the various graduates from the program in its different incarnations. The use of triangulation from
interviews, artifacts, researcher observations, and students’ perceptions from their questionnaires increases the reliability of the results (Denzin, 1989; Esterberg, 2002; Merriam, 2002; Thompson, 2003).

The instruments (COP, SATIC, goals coding and student questionnaires), while containing numbered categories, were not used for any statistical elements due to the limited number of participants. However, in addition to adding standardization among the observations (Krathwohl, 1998), the coding tools reduced the data in a way that enabled trends to be more easily seen for comparison among the teachers and the two groups of graduates. The teacher case analyses are discussed further in Chapter 4.

**Educational Goals for Students**

Analyses of all data sources were compiled to determine the extent of goal promotion in ISU SSTEP graduates’ classrooms. The researcher used teachers’ on-line questionnaire and interview responses to determine what student goals participants currently have and promote with their students. Students’ perceptions of the goals emphasized by their teachers (the ISU SSTEP graduates) were communicated through their responses to questionnaires given by the teachers. Classroom observations, interviews, and artifact analyses were combined to provide evidence for determining what goals for students were actually being emphasized and promoted in teachers’ classrooms. For example, a teacher could have used open-ended questions and posed problems for students to investigate and discuss. However, if this same teacher typically used traditional assessments of vocabulary recall and term recognition, the overall rating for the goal of critical thinking would be a moderate promotion. A teacher who used traditional cookbook activities and assessments and did not ask open-ended questions to challenge students’ ideas would receive an overall rating of low
emphasis of goals such as critical thinking, creativity, and problem solving. A teacher who
did use challenge questions along with inquiry-based activities and problem-based
assessments would be rated as having a high promotion of such goals. All of these
conclusions and considerations were then compared with the goals promoted, modeled, and
advocated by ISU SSTEP faculty in the science teaching methods courses. These goals will
be outlined in Chapter 4’s description of ISU SSTEP.

Teachers’ Habits of Mind

Various perspectives exist regarding particular habits of mind required for effective
The ISU SSTEP identifies four primary habits of mind that it seeks to model and promote for
its preservice teachers:

a) Habits of Understanding: the extent to which teachers understand the research-based
framework for their decisions in planning, teaching, and evaluating lessons.

b) Habits of Action: the extent to which teachers actually implement research-based
science instruction through their teacher behaviors, use of materials, strategies, and
assessments.

c) Habits of Reflection: the extent to which teachers monitor and evaluate their current
state of teaching compared to their desired state of teaching, with respect to a
research-based framework for science instruction.

d) Habits of Improving Practice: the extent to which teachers articulate and enact
strategies to move from their current state to desired state of teaching.

These habits were designated by ISU SSTEP faculty and combine to form an overall habit of
mind representative of the ISU SSTEP. The present study does not investigate the validity or
theoretical framework from which these particular habits of mind originate. Rather, the
study investigated the extent to which graduates of the program exhibit these habits labeled
and taught in ISU SSTEP. In the Teacher Case Analyses (Chapter 4), each teacher was rated
on his or her degree of alignment or matching to the ISU SSTEP regarding the four categories and overall habits of mind promoted, advocated, and modeled in the program. Each subcategory was identified and analyzed with respect to several exemplars in the various data sources.

Habits of Understanding, for example, were assessed mainly through data from interviews and artifacts. A high match (H) to ISU SSTEP for habits of understanding required multiple indicators of components taught in the program: explicit consideration of specific goals for students; using research on how people learn (i.e. learning theories) to inform teacher decisions; choosing appropriate content, materials, and activities; and identifying the importance of effective interactions with students. Teachers who referred to choosing teacher behaviors and activities with consideration of goals only with no allusion to any consideration of research supporting their decisions received a moderate (M) match rating to ISU SSTEP. Teachers who were ambiguous in their descriptions of interactions, goals and rationale for these decisions received a low (L) match rating to ISU SSTEP.

Habits of Action were assessed using the observation field notes, artifacts, and goal promotion data sources to determine relative matching to ISU SSTEP. Classroom observation coding tools were used to determine the alignment of this habit of mind with that promoted in the program. Teachers with relatively high COP coding had inquiry-based classrooms emphasizing student sense-making and engagement in learning. Lesson activities that supported a high match (H) were typically inquiry-based, promoting problem solving, deep content understanding, creativity, critical thinking, and collaboration. Another indicator supporting a high match (H) was a teacher who used the SATIC interaction pattern promoted and modeled in ISU SSTEP: asking open-ended questions (thought-provoking SATIC 3c,
extended-answer SATIC 4) and responding in a student-centered manner (asking for elaboration SATIC 11, using students’ comments SATIC 12). Teachers with a low match (L) in habits of action exhibited traditional top-down instruction in which the teacher typically made all of the decisions, gave students textbook assignments and “cookbook” laboratory activities that promoted passive learning in the “game of schooling.” These teachers typically asked short yes/no or fill-in-the-blank questions (SATIC 3a, 3b) and responded in a teacher-centered manner (for example, praising students SATIC 7, repeating student comments SATIC 8, and answering student questions SATIC 10). A moderate (M) match to ISU SSTEP habits of action would be a mix of the above actions, such as a teacher using inquiry-based activities but typically short-circuiting the learning and assessment by giving students answers or asking simple questions (SATIC 3a, 3b) that did not encourage discussion or deeper thinking. A lower match rating was also applied to teachers who typically used traditional “cookbook” lesson activities as well as assignments and assessments that focused on trivia memorization.

**Habits of Reflection** were determined mostly through interviews that inquired about teachers’ self-evaluation of their teaching. Those with high (H) matches to ISU SSTEP articulated their reflection in terms of a research-based framework, elaborating on their interaction patterns (questions, responses, non-verbals, etc.) with students and using research on how people learn to support their decisions. These teachers also identified and negotiated through institutional constraints they may face when implementing research-based instruction. Teachers who may have mentioned their behaviors with respect to goals for students but were less precise in their reflections exhibited a moderate (M) match. For example, they would mention asking “more thought-provoking” questions without much
elaboration on why these were ideal. Teachers with low (L) matches to ISU SSTEP habits of reflection typically focused on anecdotal stories of their experiences with students or a lesson. They gave broad answers regarding their desired state, such as “having better discussions” or “better activities.” Another exemplar was relying almost exclusively on external sources (supervisor, for example) to tell them how they were doing, as opposed to actively monitoring and evaluating themselves.

**Habits of Improving Practice** were assessed through interviews, observations, and classroom artifacts. Teachers with a high (H) match to ISU SSTEP in terms of this habit took multiple actions to improve their practice. Examples are teachers taping themselves, using signs in their classrooms to kindle open-ended questions, writing down specific questions or examples before the lesson to guide the learning, collaboration and communication with colleagues, and attending and presenting at conferences for science education. Those who may have acted on two or three of the above were rated closer to a moderate match (M) with ISU SSTEP. Those with a low match (L) to habits of improvement typically relied on some outside source to tell them how to get better (such as a supervisor), expected better activities to completely improve their entire teaching, or gave ambiguous ideas such as “trying harder.”

Finally, an **Overall Summary** of matching to ISU SSTEP was determined for each participant based on the four categories of habits of mind and their relative emphasis in each teacher’s professional practice and decision-making. This overall rating is not simply an average of the category ratings. Rather, it is a summation of the graduate’s general alignment to the habits of mind promoted, advocated, and modeled in ISU SSTEP based on analysis of all data sources: observations and coding tools, artifact analysis, interview and
questionnaire responses, and student perceptions. Teachers may receive the same overall summary rating of alignment due to different reasons. For example, one participant may exhibit a higher match to habits of action and improving practice, but may have an overall moderate match due to lower matching of habits of understanding and reflection. A second graduate may have the same overall moderate match, but receives this rating due to a low match in habits of action and improving practice and high match in habits of understanding and reflection.

Two additional ratings of moderately low (ML) and moderately high (MH) matching were added to the initial three ratings of low (L), moderate (M), and high (H) matching to more precisely evaluate and identify participants’ relative alignment with the habits of ISU SSTEP. The determination and rationale for each of these ratings are discussed in greater detail in the summary of each participant’s case analysis.

Assumptions, Limitations, and Delimitations

As with any research endeavor, assumptions exist in this study that relate mostly to the participants and program: (1) the participants are representative of the two groups of graduates from the former and current ISU SSTEP; (2) observations and artifacts are a microcosm of the teachers’ typical use of curriculum and instruction; (3) participants are truthful regarding self-evaluation, actions for improving practice, and goals they promote, as opposed to reporting what they think they are “supposed” to say, despite being told the study is an evaluation of ISU SSTEP, not the graduates.

This study is limited to the study of ten participants out of over a hundred ISU SSTEP graduates. It is also limited in time with only three observations out of an entire school year. Issues that may influence the teachers’ professional practice such as community contexts,
administrative policies, and teacher socialization are beyond the scope of this study. Regarding ISU SSTEP itself, participants from both groups had the same instructor with the same thrust of content, but one cannot expect the instructor to maintain the same classroom instruction over the years. The current ISU SSTEP group had more semesters in science methods courses; hence they received further instruction regarding classroom management, safety, nature of science (NOS), and institutional constraint. Current ISU SSTEP graduates also experienced about twice the number of hours of field experience before student teaching. However, literature indicates field experiences often interfere or thwart instruction from preservice teacher preparation programs (Bergman, 2006; Fu & Shelton, 2002; John, 2001; Sullivan, Mousley, & Gervasioni, 2000). Another difference between the ISU SSTEP formats is that students of the current program, being MAT candidates, took one of their science teaching methods courses during their student teaching semester. Graduates from the former program had their one science teaching methods course and student teaching experience in different semesters, usually student teaching following the science methods semester. A final confounding variable is the extent to which teachers developed outside of ISU SSTEP by continuing with professional readings and attending additional professional development and science education conferences. However, these behaviors are also a part of ISU SSTEP’s thrust, and teachers who do so show closer alignment with the program’s promoted habits.

Some teachers may have truthful intentions, but may not be accurately self-assessing their understanding and practice. For example, they may report having a goal of student critical thinking, but their actions of asking yes/no questions, answering student questions, and using cookbook laboratory activities all hinder the promotion of this goal. Hence,
triangulation of data by analyzing artifacts and observing lessons assists to diminish such limitations. Participants of the study are mostly teachers in their first five years of teaching between ages 25 and 30. They are mostly male, Caucasian, and teach in central Iowa. The researcher is male, Caucasian, age 30, and also from the Midwestern United States. Results and interpretations made must include consideration of these characteristics. Typically, graduates from the former program are older and have more years of experience. This added expertise may give former graduates an advantage to have honed their professional practice over more time. However, the added time away from the ISU SSTEP may also have diminished their conscious articulation and use of the habits promoted in the program. These two time variables, in a way, may counteract each other’s relative influence in the study.

Conclusions from this study of ISU SSTEP may apply to other secondary science teacher education programs in the Midwest with similar student populations. Mere extrapolation to specific SSTEPs from across the nation or globe are not as feasible without consideration of particular contexts, cultures, and other characteristics.

One may note the missing data collection of assessment scores by students of the SSTEP graduates. Practicality and reliability notwithstanding, the exclusion of such scores to determine effective instruction is supported by research. “The measures of student learning most often of interest . . . do not lend themselves to the assessment of preservice teacher education programs. To put it another way, the use of students’ scores on standardized achievement tests leads us to ask the wrong questions when investigating program efficacy” (McNergney & Imig, 2006, p. 3). McNergney and Imig describe student achievement as one coin in the currency of teacher education research. Research that focuses on one coin in the mass of change will miss a surplus of data. While student scores may
provide additional insight in data analysis, their absence does not dramatically diminish the present methodology’s worth. The present study intends to extract several denominations of data regarding graduates of ISU SSTEP.
CHAPTER 4: RESULTS AND ANALYSIS

Summary of Problem

Teacher education continues to toil in creating lasting change in the quality of the nation’s schoolteachers. Institutions’ successes and failures seem interchangeable and unpredictable. Much of the uncertainty stems from a lack of purposeful investigation into the role of teacher educators (Lanier & Little, 1986). As a whole, teacher education and its true potential to impact change are mostly “unstudied” (Sarason, Davidson, & Blatt, 1986). Insufficient research and understanding create a convoluted landscape of preparation schemes ranging from traditional university programs to alternative certification, the latter including its own array of diverse approaches and agendas. The effects of a shotgun approach are schools full of confused teachers and students. Science education is at the forefront of these struggles (Craven & Penick, 2001; Windschitl, 2005). The uninformed public despairs at paltry achievement (Lemonick, 2006) and ill-equipped teachers begrudge their insufficient preparation experiences (Sullivan, 2006).

This study endeavors to examine the true impact of a secondary science teacher education program on teachers’ understandings and habits. It seeks to determine how ISU SSTEP’s features and increase in time (one semester of science teaching methods to multiple semester) impact the alignment of teachers’ habits of mind and promotion of student goals to those same aspects identified, modeled, and advocated by the program.

Review of Research Questions

As stated in the introduction, this study makes no claims about the impact of ISU SSTEP on 7-12 students’ science achievement. Rather, the focus is on how well ISU SSTEP
produces teachers that exhibit the behaviors and understandings modeled and promoted in the program. The following questions are central to this study and address the primary categories:

1. Educational Goals for ISU SSTEP Graduates’ Students:
   a. What do graduates of the former and current ISU SSTEP report are their goals for students?
   b. What do secondary students in the classes taught by former and current ISU SSTEP graduates perceive are the goals promoted in the class?
   c. In classroom observations of former and current ISU SSTEP graduates, what goals appear to be promoted?
   d. How do these results compare to the science education goals modeled, promoted, and advocated by ISU SSTEP faculty?

2. Habits of Mind of ISU SSTEP Graduates:
   a. What habits of mind—understanding, action, reflection, improving practice—do former and current ISU SSTEP graduates exhibit?
   b. How do these compare to the habits promoted and modeled in ISU SSTEP?

This study has two purposes. The first purpose is to examine perspectives of goal promotion in classrooms of former and current ISU SSTEP graduates, and to compare these results with the goals promoted in ISU SSTEP. This first topic is akin to the much larger study of Goodlad (1983, 1984) and his colleagues of student goals in America’s schools. The second purpose is to identify the habits of mind exhibited by graduates of the former and current ISU SSTEP, and to compare these results with the goals promoted in ISU SSTEP. These habits of mind were self-designated and modeled by ISU SSTEP science teaching methods faculty. Data collected and analyzed for topic one questions about educational goals are also used in the analysis of findings for the more extensive topic two questions about habits of mind promoted in ISU SSTEP.
Four main sections comprise the rest of this chapter. The first section describes the former and current ISU SSTEP. The second section provides the case analyses for each of the ten teachers who participated in the study. The last two sections of Chapter 4 discuss findings to the two research questions with respect to the data collection and analysis.

**Former and Current ISU SSTEP**

**Former ISU SSTEP Structure**

The former ISU SSTEP (Spring 2000 to Spring 2003) was solely an undergraduate licensure program consisting of the courses, field experiences, and credits appearing in Table 2.

Table 2: Required courses and credits (cr) in former undergraduate ISU SSTEP

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Psychology</td>
<td>3 cr</td>
</tr>
<tr>
<td>Social Foundations of American Education</td>
<td>3 cr</td>
</tr>
<tr>
<td>Multicultural Gender Fair Education</td>
<td>3 cr</td>
</tr>
<tr>
<td>Education of the Exceptional Learner in a Diverse Society</td>
<td>3 cr</td>
</tr>
<tr>
<td>Instructional Technology</td>
<td>3 cr</td>
</tr>
<tr>
<td>Principles of Secondary Education</td>
<td>3 cr</td>
</tr>
<tr>
<td>Secondary Science Methods</td>
<td>3 cr</td>
</tr>
<tr>
<td>Pre-Student Teaching Field Experience</td>
<td>3 cr</td>
</tr>
<tr>
<td>Student Teaching (minimum of 50 clock hours)</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

36 credits total

**Current ISU SSTEP Structure**

The current ISU SSTEP (Fall 2003 to Present) offers both undergraduate and graduate licensure. The courses, field experiences, and credits for both programs appear in Table 3.
Table 3: Required courses and credits (cr) in current undergraduate and graduate ISU SSTEP

Current Undergraduate ISU SSTEP:

Educational Psychology (3 cr)
Social Foundations of American Education (3 cr)
Multicultural Gender Fair Education (3 cr)
Education of the Exceptional Learner in a Diverse Society (3 cr)
Instructional Technology (3 cr)
Introduction to Science Teaching (1 cr)
Nature of Science and Science Education (3 cr)
Secondary Science Methods I (2 cr)
Secondary Science Methods II (2 cr)
Pre-Student Teaching Field Experience (minimum of 100 clock hours/5 cr)
Student Teaching (12 cr)

40 credits total

Current Graduate ISU SSTEP (MAT):

Educational Psychology (3 cr)
Social Foundations of American Education (3 cr)
Multicultural Gender Fair Education (3 cr)
Instructional Technology (2 cr)
Teaching Students with Disabilities (3 cr)
Introduction to Science Teaching (1 cr)
Nature of Science and Science Education (3 cr)
Secondary Science Methods I (2 cr)
Secondary Science Methods II (2 cr)
Advanced Science Pedagogy (3 cr)
Masters Degree Project (3 cr)
Pre-Student Teaching Field Experience (minimum of 100 clock hours/5 cr)
Student Teaching (12 cr)

45 credits total
The current and former programs differ in the following respects:

1. The semester length 3 credit general teaching methods course in the former ISU SSTEP has been eliminated.

2. Both undergraduate and graduate students in the current ISU SSTEP complete three and 4 tightly sequenced and coordinated science methods courses respectively.

3. Both undergraduate and graduate students in the current ISU SSTEP complete a minimum of 100 clock hours in a secondary school classroom prior to their 12-week student teaching experience (compared to 50 minimum hours in the former ISU SSTEP).

4. Both undergraduate and graduate students in the current ISU SSTEP complete a 3-credit “Nature of Science and Science Education” course during the same semester they complete Secondary Science Methods I.

5. Graduate students in the current ISU SSTEP complete their fourth science teaching methods course following student teaching.

6. Graduate students in the current ISU SSTEP complete a Masters Degree Project following student teaching.

7. The credits earned in the former, current undergraduate, and current graduate ISU SSTEP are 36, 40, and 45 respectively.
The differences are summarized in Table 4.

Table 4: Summary of differences between former and current ISU SSTEP

<table>
<thead>
<tr>
<th></th>
<th>Former</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undergraduate</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>General teaching methods  course</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Science teaching methods course</td>
<td>1</td>
<td>Sequence of 3</td>
</tr>
<tr>
<td>Clock hours in field placement</td>
<td>50 minimum</td>
<td>100 minimum</td>
</tr>
<tr>
<td>Nature of Science and Science Ed. Course</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Coursework after student teaching</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Masters degree project</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cohort group during science ed. courses</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Minimum education credits</td>
<td>36</td>
<td>40</td>
</tr>
</tbody>
</table>

Both program versions included required general education courses in educational psychology, multicultural education, foundations of teaching, educational technology.

Focus and Substance of Former and Current ISU SSTEP Programs

While significant differences exist in the structure of the current and former ISU SSTEPs, three crucial variables have remained, to the extent possible, constant. First, the instructor who taught the former ISU SSTEP science methods course also teaches the first three science methods courses and the nature of science course in the current ISU SSTEP. Second, the overarching purpose of ISU SSTEP has remained the same—to prepare highly effective decision-makers who appropriately use the science education and general education research-base to create powerful learning environments for the students they teach. Third, the kind of assignments in the science teaching methods courses has remained the same, but students are expected to more thoughtfully apply what they are learning as new ideas are addressed and old ideas revisited repeatedly in new contexts. The following will more clearly illustrate this.
The visual framework in *Figure 1* (Clough & Berg, 2006) was created to help preservice and inservice science teachers conceptualize teacher decisions, and understand their importance and interactions. First generated by Clough and Berg in 1988, the Visual Framework has since undergone several iterations (Clough, 1992; Clough & Kauffman, 1999; Clough, 2003; Clough & Berg, 2006) leading to what is presented here. The Visual Framework makes explicit the crucial and incessant role of assessment in teacher decision-making. While the Visual Framework certainly does not capture all that goes into learning and teaching, it must be seen in its purpose of assisting novice and experienced teachers to make sense of the complex decisions they often unknowingly make moment to moment in the classroom. Iterations of the visual framework were used throughout the science methods courses in both the former and current ISU SSTEPs to help students understand and wrestle with the many decisions that teachers make and how those decisions interact with one another.

The visual framework illustrates the overarching purpose of both the former and current ISU SSTEPs. Moreover, iterations of the visual framework were used in both the former and current ISU SSTEPs to guide students’ thinking when completing all assignments in the former and current ISU SSTEP science methods courses. For instance, in both the former and current ISU SSTEPs, students created 10-day lesson plans. These lesson plans were required to address what science content would be taught; what tasks, activities and materials would be used; what teaching strategies and models would be implemented; and crucial teacher behaviors and interaction patterns. All of these decisions had to be defended in light of the purposes of schools and schooling, desired student goals, how students learn, and education research that is relevant to the decisions made (Clough & Berg, 2006).
Visual Framework Illustrating Teacher Decision-Making
(Clough & Berg, 4/20/06)

Student Goals

consistent with

Student Actions

selected to promote

informs decisions regarding

Key Teacher Decisions

Selection of teacher behaviors & interaction patterns
Selection of teaching strategies & teaching models
Selection of content, tasks, activities & materials

selected to understand

informs decisions regarding

The Learner

Student’s Thinking
Student’s Self-efficacy
Student’s Prior Knowledge
Student’s Developmental Differences
Student’s Zone of Proximal Development

Figure 1: Visual framework illustrating teacher decision-making and their interactions
A second assignment that illustrates the thrust of the former and current ISU SSTEPs and how the visual framework was used to promote attention to teacher decision-making was the teaching self-evaluation. Students in both the former and current ISU SSTEPs were required to audiotape themselves on a regular basis when interacting with students. The assignment required that they select a 10-minute continuous section of audiotape, code their interaction using the SATIC instrument (See Appendix B-2); transcribe ten questions that were asked on the audiotape; write a rich self-evaluation summary that addresses all aspects of the visual framework; and provide an action plan to improve their interaction pattern.

The signature assignment in both the former and current ISU SSTEPs science methods courses is a student’s writing and oral defense of a research-based framework (RBF) for teaching science (Clough, 2003b; Clough & Kauffman, 1999). RBF papers are typically 20 to 35 pages long, contain more than 30 references, and, in addition to addressing all the components in the visual framework, include: why science should be taught; why students have chosen to teach science; and how students will provide evaluation of their program, students, and themselves. Students must justify their decision-making, and research support is expected to be extensive. Papers are due two weeks prior to the end of the science methods course in the former ISU SSTEP and in the Secondary Science Methods I and II courses in the current ISU SSTEP.

During the last two weeks of courses that require the RBF, each student meets individually with the instructor for a 1½-hour oral defense of their research-based framework (RBF) paper. A little over one hour of this oral defense is devoted to a discussion regarding a student’s understanding of teacher decision-making that promotes effective teaching and robust learning. The instructor asks questions during the oral defense, some of which have
been prepared beforehand based on what appears in typical RBF papers. However, most all instructor comments and questions follow from closely listening to what students say during the oral defense. Much of what the instructor does is ask for clarification of a student’s ideas, and ask questions that help both the instructor and student understand the depth of the student’s knowledge regarding learning and effective teaching.

During the last twenty minutes of the oral defense, students are provided copies of the course objectives, course major activities and expectations, and grade definitions and rubric appearing in the course syllabus. They must then consider their performance in light of all these documents and accurately assess their performance in the course. Students do not receive the grade they want, but rather the grade they can justify based on their performance during the course compared to the expectations laid out in the course syllabus. The entire oral defense is audio taped, and the RBF paper and oral defense together acted as the culmination of the science methods course in which they occurred. Yet the RBF paper and oral defense were also a foundation upon which students were encouraged to continue their career-long development as teachers. The oral defense plays a key role in helping students understand where they must grow to become a highly effective teacher. School principals rarely visit classroom and assess teachers’ practice more than two or three times during a school year. Moreover, their feedback is not always accurate or meaningful. Becoming an effective educator demands that teachers accurately self-assess their performance and this is what is promoted in the RBF oral defense and previously described audiotape self-analysis.

While these three assignments and others are the same in both the former and current ISU SSTEP science methods courses, in the current program students complete the assignments multiple times. The 10-day lesson plan is assigned in Secondary Science
Methods I and again in Secondary Science Methods II. One audiotape self-analysis is assigned in Methods I and two or three audiotape self-analyses are assigned in Methods II.

In the current ISU SSTEP, portions of the RBF are first assigned during the Introduction to Science Teaching, extensively added to in Secondary Science Methods I, and significantly improved in Secondary Science Methods II.

All science teaching methods courses have been—and still are—conducted face-to-face (as opposed to internet-based or satellite broadcasts), each taking place on the university campus. The instructor of the science teaching methods courses in both the former and current ISU SSTEPs made great effort to model research-based teaching strategies, and draw attention to his teacher behaviors, the decisions that he was making, and the research-based rationale for those decisions. The personal contact and direct modeling of effective teaching was deemed vital for conceptual change of preservice students’ notions of science education. The following statement that appeared on the front of the course syllabus for science methods courses in both the former and current program illustrates the effort and significance the instructor placed on modeling effective teaching and decision-making:

This course is a reflection of education research that applies to the emerging consensus regarding the goals for science education. Whenever you perceive a discrepancy, you are expected to respectfully ask, “What is your rationale for . . . ?”

The instructor’s explicit modeling of effective teaching, providing his rationale for decisions made, and the course assignments were all directed at promoting among students habits of thinking, action, reflection, and implementing plans for improving their practice.
**Significant Differences between the Former and Current ISU SSTEP**

While the thrust and substance of the former and current ISU SSTEPs share many similarities, important differences exist and these reflect the ISU science education faculty’s view that a one semester science teaching methods course is insufficient to deeply understand the complexities of learning and teaching, and to develop habits of thinking, action, reflection, and implementing plans for improving their practice. The current ISU SSTEP was designed to provide significantly more time for students to wrestle with the complexities of learning and teaching and develop the desired habits. Moreover, students in the current ISU SSTEP complete Secondary Science Methods I and its associated internship, Nature of Science and Science Education, and Secondary Science Methods II and its associated internship as a cohort. This change was made to encourage the development of a culture consistent with the program’s thrust.

The addition of a Nature of Science and Science Education course is an important difference between the former and current ISU SSTEPs. The course confronts prospective teachers’ naïve ideas regarding what science is and how it works, attempts to convince students that accurately portraying the nature of science is an important science education outcome, and addresses how to effectively teach the nature of science. This course also emphasizes to prospective teachers the unnatural nature of scientific thinking, and how this accounts for much of the struggle students have in learning science. Thus, the course addresses important content (i.e. the history, philosophy, sociology and psychology of science), but also addresses how to effectively teaching science. This, it may be thought of as a quasi fourth science teaching methods course in the current undergraduate ISU SSTEP, and a fifth science teaching methods course in the current graduate level ISU SSTEP.
Another key difference between the former and current ISU SSTEP is the increase from 50 to 100 clock hours of field experience prior to student teaching. More time in schools has both positive and negative implications. Prospective teachers need to interact with students in learning how to teach. However, evidence indicates that field-based placements must be carefully made and well-connected to university-based teacher education. Otherwise, prospective teachers are simply immersed in, and often adopt, practices that may very well be ineffective (Bergman, 2006; Goodlad, 1990c; Talvitie, Peltokallio, & Mannisto, 2000). The current ISU SSTEP increased the number of school-based internship hours prior to student teaching from 50 to 100 hours. However, those field-based placements are made with care and tightly connected to the university-based science teaching methods courses (as they were with the former ISU SSTEP).

**Summary of the Former and Current ISU SSTEPs**

The focus and substance of the former and current ISU SSTEPs are, to the extent possible, the same. The same instructor taught the science education component of both programs. The science education component of both programs encouraged the development of a solid theoretical foundation for research-based decision-making in complex and dynamic classrooms. Teaching was viewed and taught as thoughtful intentions, diagnose situations and make decisions based on these judgments (Clough, 2003b; Clough & Kauffman, 1999). The particular activities and strategies used in the science education component of ISU SSTEP were not ends in themselves. Rather, they were efforts to have students understand how effective teacher decision-making is based on a solid understanding of teaching and learning. At issue is moving beyond the training of basic skills and techniques (pedagogical knowledge, or PK) as well as specific ways of teaching particular content (pedagogical
content knowledge, PCK) such as analogies, illustrations, and demonstrations to represent individual concepts (Colton & Sparks-Langer, 1993; Shulman, 1986a, 1986b, 1987; Yeany, 1991).

However, unlike the former ISU SSTEP, the science education component of the current ISU SSTEP is tightly coordinated, and reflects a spiraling curriculum that revisits concepts in increasingly complex contexts. This is in contrast to the smorgasbord of disconnected courses in teacher education programs so often reported in the literature (Goodlad, 1990b, 1990c, 1994; Lanier & Little, 1986). Students in the current ISU SSTEP completed their science education courses as a cohort. They had 50 more hours of field-based teaching experience linked to their science teaching methods courses prior to student teaching. Perhaps most importantly, students in the current ISU SSTEP have far more time to wrestle with the complexities of learning and teaching, including:

- generating a more thoroughly examined and developed set of student goals;
- considering student actions that are consistent with those goals;
- deeply investigating how students learn science (including constructivist, social, developmental, and behaviorist perspectives, and considering implications of the nature of science for learning science concepts);
- understanding and practicing teacher behaviors, and reflect upon their complex interplay (questioning, responding, wait-time I and II, listening, non-verbals, etc.);
- linking classroom management to other aspects of effective teaching;
- accurately reflecting on practice and making actions plans for improving practice;
- assessment, curriculum integration and modification; and
• considering all teacher decisions in light of desired goals, how people learn, and their interaction with other teacher decisions;

Thus, the current ISU SSTEP provides far more time and experiences to promote among students its sought after habits of thinking about teaching, actual classroom practice, reflection on that practice, and efforts to improve practice. Those sought after habits are:

**Habits of Understanding:** The ISU SSTEP promotes the habit of seeing teaching as highly complex decision-making that takes into account all aspects of the visual framework in *Figure 1*. In lesson plans, self-analyses, the RBF paper and oral defense, and other assignments, students must address aspects of the schematic and their interactions. Extensive effort is made in the science education courses of the ISU SSTEP to model effective teaching and draw students’ attention to the complex decision-making reflected in the visual framework.

**Habits of Action:** Science education faculty in the ISU SSTEP make clear to students that habitually understanding and thinking about the complexities in teacher decision-making is not enough. The former and current ISU SSTEP science education courses worked to develop in students particular habits of action that play out in actual teaching. Students were expected to analyze their practice and put into practice what they were learning about effective teaching. Students were repeatedly encouraged to work at developing habits of action related to each aspect of the visual framework.

**Habits of Reflection:** During the science education component of both the former and current ISU SSTEP, explicit discussions occurred that made students aware that they entered the program unconsciously incompetent about the complexities of learning and teaching. That is, they had some strongly held misconceptions regarding what effective
teaching entailed. Students soon became consciously incompetent, aware that they had significant misconceptions about effective teaching. As students moved to varying levels of consciously competent, explicit discussion occurred about the danger of becoming unconsciously competent. The need to continually understand and reflect about practice was a common theme in both the former and current ISU SSTEPs. The detailed audiotape self-analysis of classroom practice, and the demand that students accurately self-assess their performance in the science teaching methods course at the end of the RBF oral defense illustrate the efforts made in ISU SSTEP to develop in prospective teachers the habit of reflection.

**Habits of Improving Practice:** Both the former and current ISU SSTEPs made clear that accurate self-assessment was important, but insufficient, for improving practice. Students in the science teaching methods courses were required to put forth realistic action plans for improving their practice. For example, to improve wait-time I and II, a poster that simply states “WAIT” might be placed in a visible location in the room to remind a teacher in the act of teaching to use appropriate wait-time I and II. Other sorts of action plans were discussed and modeled for students to encourage them to develop the habit of creating and implementing action plans for improving their practice.

The remainder of this chapter reports on the extent that participants in this study reflect those four general habits promoted in the former and current ISU SSTEPs.

**Teacher Case Analyses**

This section provides an in-depth description and analysis of teachers studied in this project. The case analysis features the following components for each participant:
1) An overview of the teacher’s experience and school setting;
2) Content and activities used in lessons along with COP coding from classroom observations;
3) A description of the teacher’s interaction pattern including questioning, responding, and non-verbal behaviors, featuring data from the SATIC coding tool;
4) Educational goals promoted for students, as collected from the teacher’s self-reporting, student questionnaires of perceived emphasis, and classroom observation and artifact analysis;
5) Comments and insight obtained from teacher interviews and conversations;
6) Analysis of classroom artifacts (materials, assessments, handouts, projects, etc.);
7) A summary and analysis of the extent to which the teacher matches the habits of mind promoted and modeled in ISU SSTEP.

Methods for data collection and analysis were described in Chapter 3, including the process of determining levels of matching to ISU SSTEP habits of mind.

The Perceived Goals for Students section in the following teacher case analyses includes teachers’ self-reported goals for their students. In these lists, those goals with an asterisk (*) are indicated by the graduates (via their on-line questionnaire responses) as getting the most emphasis in their teaching. Parentheses and numbers (#) followed any self-reported goals that corresponded to goals listed on the student questionnaires and goals observation sheet.

The teacher case analyses are grouped according to former and current ISU SSTEP graduates. The former graduates (F-1 through F-5) are featured first.

**Teacher F-1: 4th Year Teacher (Former Program)**

**Overview**

Teacher F-1 has taught for four years and has also completed a master’s degree in science education (Curriculum and Instruction) at the same program. Nevertheless, she comes from only one semester of methods in her preservice program. She teaches 7th grade science at a middle school in a growing suburban, middle-class community. She is also
responsible for teaching social studies as half of her teaching load. Although she is not a new teacher, Teacher F-1 had immense struggles with effectively leading and managing her classroom. Students were allowed to be boisterous and off-task, playing with props and materials like scissors during times they are supposed to be actively working on projects. Teacher F-1 used a louder “teacher voice” to try to manage students, but any impact this had on students’ attentiveness was short-lived. It usually just increased the volume of the overall class noise. Teacher F-1 gave momentary threats, stern looks, and disapproving comments, but took no direct action to address behavior problems. Also, the tone of Teacher F-1’s comments was often sarcastic and disrespectful, which only perpetuated the same behaviors in the students (those that understood sarcasm).

Content, Activities, COP Coding

On the surface, it appears that Teacher F-1 attempted to promote creative problem solving in her choice of activities. However, these hands-on projects were simply activities with no deeper investigation. Little or no critical thinking, inquiry, or deep understanding was required of the students. Examples include a large licorice/gumdrop model of DNA, drawing dog faces of a family to show genetic probabilities, and round robin recitation (observation 3). The latter occurred in a review of science terms, during which students first had to share an analogy of various organs. While this may have possibilities for encouraging creativity and thoughtfulness in students, Teacher F-1 responded to nearly every analogy with a nod or “okay” and failed to check for understanding or engage the learners by asking “how is it like . . .?” for example. The round robin session was nothing more than a pedantic game of short-term memory, during which students could simply repeat what a peer said five seconds earlier. Overall, Teacher F-1’s choice of activities for lessons had low reflection of
the NSES standards for inquiry, intellectual engagement, collaborative interaction and respect (See Figure 2).

![Figure 2: COP coding for Teacher F-1](image)

*Maximum Capsule rating is 8; all other categories have a maximum rating of 5*

**Teacher Behaviors and SATIC Pattern**

Teacher F-1 exhibited frustration with her students on their inability to stay focused. However, she did not actively behave in a way to model and teach the desired behaviors for her students.

**Questioning:** Teacher F-1’s initiatory behaviors included 38% talking to students as either lecturing (SATIC 1) or making statements (SATIC 2). As seen in Figure 3, initiatory questions were typically yes/no/dichotomous (SATIC 3a; 16 total incidents; 47% of all initiatory questions) or short-answer (SATIC 3b, 13 total incidents; 38%). Questions
promoted by ISU SSTEP (SATeC 3c and 4) were negligible. Four thought-provoking questions (SATeC 3c) and one extended-answer question (SATeC 4) occurred in the first lesson observed. Neither type of question occurred in the second or third observation. The lessons focused mostly on science content (as opposed to procedures, skills, or calculations). Opportunities existed for more posing thought-provoking questions. For example, when discussing meiosis and mitosis, Teacher F-1 led the presentation by making statements (SATeC 2) or asking simple yes/no or short-answer questions (SATeC 3a, 3b). Instead, she could have posed higher-level questions to engage students in thinking and assess their understanding. Possibilities would be “Why do you suppose the cell nucleus splits in half during mitosis?” or “Why do you think sex cells only have half the number of chromosomes?” Instead, the presentation and resulting activity had a cookbook format in which students repeated terms about the process of mitosis without engaged consideration of the concepts or their applications.

**Responding:** Teacher F-1’s response behaviors were typically teacher-centered such as rejecting student comments, repeating student comments, and answering student questions. Rejection of student comments (SATeC 5) occurred 13 times during observations, accounting for 22% of all responses. This included giving negative statements to indicate students’ answers were incorrect or what the teacher wanted to hear. These occurred during the review of concepts when students gave their analogies of organs or definitions. Teacher F-1 also frequently responded to student comments by repeating their comments (SATeC 8). This happened 16 times during observations, accounting for 27% of all responses. Teacher F-1’s habit of repeating comments occurred frequently while other students were talking in the class. Students who shared comments had to compete with peers who were also sharing
ideas or talking off task at the same time. Lack of classroom management or instruction about effective communication resulted in Teacher F-1 having to repeat comments. The third primary form of response Teacher F-1 used was answering student questions (SATIC 10). This occurred 15 times and accounted for 25% of all of Teacher F-1’s responses. On one occasion, a student asked why certain ligaments were called the ACL and MCL. Teacher F-1 responded by answering “I don’t know.” Later, when students pressed her for a response about the same question, Teacher F-1 responded by asking, “You want to look it up?” Students took this response as a threat or punishment. Their query about the word origin ended with no further investigation. The three most predominant responses (SATIC 5, 8, 10) accounted for 73% of Teacher F-1’s responding pattern. The ISU SSTEP addressed the ineffectiveness of these three responses, as they limit student confidence, contributions, and
critical thinking. In three classroom observations, only 12% (7 incidents) of Teacher F-1’s
responses asked for students to clarify their ideas (SATIC 11). Six of these responses
occurred in one lesson, two of which were the response, “Why?” to students. In three
classroom observations, Teacher F-1 responded by using a student question or idea (SATIC
12) only once. Teacher F-1 did use the value-neutral SATIC 6 response to acknowledge
student comments six times, all in the third observation while she interacted with student
pairs reviewing their study guides for the human organs unit.

**Non-verbal Behaviors:** During the first lesson observed (presentation and cell
division activity), Teacher F-1 used “okay” and “all right” excessively (9 times) to the point
of exhibiting an annoying mannerism (SATIC 15). She used inappropriate wait-time I
(SATIC 13a) during all three lessons (8 total incidents) and inappropriate wait-time II
(SATIC 13b) a total of 3 times. These instances of not giving students time to respond to the
teacher or each other accompanied Teacher F-1’s use of faster interactions in an attempt to
lower classroom management problems. A group of 5-7 students were usually off-task or
talking out of place at any given moment during the classroom lesson.

Teacher F-1’s body language and facial expressions communicated exhaustion and
impatience with students. Smiles were seldom and usually accompanied a sarcastic remark.
The classroom had a unique arrangement of desks on either side, allowing Teacher F-1 an
open space (or stage) in the center of the room. Teacher F-1 used this center space to move
around the room to various student groups. However, most of this interaction and proximity
was more of a management practice of asking students questions to see if they were on-task.
For roughly 95% of the class time, Teacher F-1 remained in this central area of the
classroom, where all of the desks face her. During activity times, pairs of students sat in
second rows or in the back of the room near the lab tables without much interaction with the teacher or other students. As a result, much of the student pair dialogue was off-task or about procedures rather than ideas or concepts.

**Perceived Goals for Students**

Teacher F-1 was the only ISU SSTEP graduate participant who did not respond to the on-line questionnaire. However, she did list the following twelve goals at the front of her classroom:

a) Students will demonstrate a deep robust understanding of science concepts (#11)
b) Students will use critical thinking skills (#2)
c) Students will convey an accurate understanding of the nature(s) of science and history of science (#3)
d) Students will be creative and curious (#7)
e) Students will exhibit communication and cooperative skills (#5)
f) Students will identify and solve problems effectively (#4)
g) Students will set goals, make decisions, and self-evaluate (#8)
h) Students will convey self-confidence and a positive self-image (#1)
i) Students will access, retrieve, and use scientific knowledge in investigating phenomena (#10)
j) Students will demonstrate an awareness of the importance of science careers (#12)
k) Students will relate science to life and evaluate how science has changed their world and thinking
l) Students will actively participate in working towards solutions to local, national, and global problems (#6)

Data from the goals questionnaires Teacher F-1 gave her students corresponds to the classroom observations. Only five goals had an average response rank of being promoted at a “much” (4) or higher level. Seven goals were reported with an average rank between moderate (3) and much (4) promotion. The lowest score was Goal #6: Participate in working towards solutions to local, national, and/or global problems with a mean ranking of 3.43 (SD = 1.226). The second lowest scored goal was #8: Set goals and/or self-evaluate (mean =
3.73, SD = 1.108). The latter ranking is interesting, as this goal is directly related to the explicit action of having students write semester goals and action plans and hanging these papers from the ceiling.

![Figure 4: Student goals questionnaire results for Teacher F-1 (N = 102)](image)

While student questionnaires indicate otherwise, observations of Teacher F-1’s classroom and analyses of artifacts indicate that few goals are typically promoted at such an extensive level. Perhaps the discrepancy between student responses and anecdotal data is due to the door-sized poster listing Teacher F-1’s goals for students at the front of the classroom. Students see such goals in large print every time they look at that corner of the room. To some extent, moderate promotion exists for goals of self-confidence (#1), using cooperation and communication (#5), creativity (#7), and a positive attitude about science (#9). Goals unnoticed among the classroom observations and artifact analyses include critical thinking (#2); an understanding of NOS (#3); problem solving (#4); working toward
solutions to local, national and global problems (#6); effectively accessing and evaluating resources (#10); demonstrating a deep understanding of content (#11); and demonstrating an awareness of science in careers (#12). Content is relegated to memorization and regurgitation of terms. Limited assessment, application of concepts, and consolidation of ideas exist. Goal setting is addressed through having students write goals for the semester on a piece of paper and then hanging them from the ceiling. These goals were mostly along the lines of “get an A instead of a B” or “get all of my assignments finished.” The back of the paper included a one- or two-item list of what the student would do to accomplish this goal. These actions, too, were nondescript and included statements such as “work harder” and “pay attention and ask for help.” This form of goal setting and self-evaluation was negligible in its implementation and impact. Much like the classroom behaviors and strategies Teacher F-1 discusses doing, her goals have sanctimonious and superficial value.

**Interview**

A surprising aspect of Teacher F-1’s classroom practice is that she has a graduate degree from the same program of her preservice preparation and methods class. She has even studied some teachers from the same program in pilot research similar to some aspects of this present study. Throughout the semi-structured interview and other conversations during visits, Teacher F-1 was quick to identify effective practice and habits she should be doing with her students. She relates her current teaching to her written research-based framework for teaching science in the ISU SSTEP. This reflection also includes an assessment of her current teaching practice and understanding:

I would probably say I’m in the middle of how effective I am at using my RBF. I reflect upon it. I think about it a lot, especially with my questioning because that’s my individual goal for this year at school—to work on my questioning and get those
higher order thinking skills. But as for . . . the number one thing it helped me learn was my reflection on my thinking—while I’m teaching and after I’ve taught. So how important that is, because I think that makes you a good teacher. If you can reflect and realize, “Oh, I did that horrible,” you can go to the next period and be like, “Okay, this is how I can change it. This is how I can fix it.”

Teacher F-1 identifies several barriers to effective practice. She struggles with differentiating between what she is “told to do” and what she knows is best for students.

I do feel a little guilty conscious over me when I’m doing things according to how I’m told to do it from my associates. And I know they’re bad. [laughs] But they [say] “You’ve got to do it this way.” And I [groan]. I’m just frustrated, so that’s one thing. And sometimes I feel frustrated because I haven’t had the chance to take [the graduate science education class] “Restructuring Activities.” And I’d like to, because I know there’s definitely activities out there that need to be restructured. So I’d say [my current teaching is] somewhat there, somewhat not really there. I’d say reflecting-wise, I know where I’m at and where I need to get to. And as long as I know how to get there, I’m okay.

Teacher F-1 does articulate her rationale for having goals for students, describing her typical interactions with students in class:

I explain at the beginning of the year, “It’s not just content that I want to prepare you for, because content is important, but there are other things that I really want to prepare you for. One reason why we teach you guys science is not just to prepare you for the next stage in science, but to actually make you globally and country-wide aware of what’s going on and what should make a good citizen and stuff like that. You’ve got to realize that we’re not just going to be focusing on one goal at every time. A lot of goals blend into each thing that we do. So this sort of gives me a rationale for why we do things.”

So when a kid asks me, “Why are we doing this?” I [answer], “Look at goal five or goal number six . . . These are the goals for you that I want to see you achieve. It’s always good to achieve, feel accomplishment, achievement, and that’s why we do these.” So that’s pretty much what I give them. I point them out to them, “This covers these goals.” [Having goals] also keeps you in focus when it comes to lesson planning. What goals am I obtaining with that? Are they going to be successful at these goals?

Interestingly, Teacher F-1 takes a teacher-centered approach to help her students learn the rationale for her goals. Answering their questions—as opposed to asking students why they
might suppose these goals exist—is counter to several goals she actually wants to promote, such as critical thinking, creativity, problem solving, and communication. Again, disconnect exists between understanding and practice.

When Teacher F-1 reflects on her current practice, she again mentions regret at not doing all she wants to, and wanting an outside source to foster this change. In the following case, the desired resource is more time:

I really wish I had more time to do the lessons, because I don’t really remember how to convert the lessons into more meaningful activities. I mean, I have an idea of what to do and stuff like that. And I try, but I don’t know how successful they really are, except according to how my kids test.

Time has a negative impact as well, as Teacher F-1 notes the accumulating years from her undergraduate ISU SSTEP experience have diminished her understanding. She gives no allusion to her own efforts in actively reflecting and implementing change.

When asked about her process of planning and teaching a lesson, Teacher F-1 does indicate consideration of her goals and her students’ present knowledge. Still, she struggles with negotiating between her own choices and external forces:

I think of my goals first, as to what are the goals and what’s the lesson going to provide for those kids and stuff. I pretest [the students], because I look at what they do and don’t know. That way, I know what we need to focus on the most. I also think about how I’m going to approach it—what learning activity we’re going to do in order to achieve what I want. You have to really think, “Okay, well, what do I want out of it? What end result do I want?” And at my school, it’s pushing for getting those test scores right now since we’re on No Child Left Behind and stuff. So I’d say definitely the goals, the misconceptions you’re going to face, the end point of where you want to be, and how you’re going to get there—what instructional strategy are you going to do? You really have to think, “Okay, is this activity . . . really going to get you from point A to point B?” And that’s where, like I’ve said, my colleagues and I sort of butt heads. And I feel like, “Oh, I don’t know if I’ll do it right.” And sometimes I’ll resort to what they say. And that’s just my own fault for not saying, “Okay, I’m going to do it my way.”
Teacher F-1 begins her planning and teaching with intentions based on her research-based decisions. However, she quickly turns these choices over to the direction of outside forces with uneasiness and without erudition of her own professional practice. Whether the source is a professor, undergraduate class, district mandates, or colleagues, Teacher F-1 concedes to their voice, wavering among these various directions.

When asked about her colleagues and their interactions with her, Teacher F-1 describes their teaching and planning decisions. She questions this approach with respect to her own goals.

They like to lecture. And you know, I’m not a lecturer. They [say], “We’re going to give notes.” Okay, so how are you going to give notes? Are we just going to stand there with a PowerPoint and stuff like that? Or how are you giving notes? Because active thinking to me is not the kids sitting there and writing down every single word that’s on the PowerPoint. I mean, any kid can do that. But are they actively thinking about it? To me, no, because I just look at them, and [the students] have that blank expression on their face and stuff. And they’re not asking questions.

So I’ve learned to turn it around if we’re going to give notes or if they think they need notes. And today I realized that when I start switching questions and asking questions from their previous readings or something, [the students realize], “Oh, this sounds familiar, but it’s not the same question as on my worksheet. But it sort of sounds familiar.” And they try. And the other thing is that they’re asking questions about it, so I know that they’re thinking about it at the same time. Whereas before, when I was just giving notes, I [would think], “This doesn’t work for me.” [laughs] If I’m not having fun, there’s no way they’re having fun.

Teacher F-1 communicates dissatisfaction with her colleagues’ approach to teaching. Her reasons are somewhat ambiguous and based on opinion more than a research framework. For example, she refers to the role of lecturer as a personality trait. Moreover, reasons for asking questions and encouraging dialogue with her class are to increase “fun” as well as student engagement. Perhaps due to these inexact rationales, Teacher F-1 continues to
struggle with her understanding and teacher decision-making. This incompleteness arises among the stress in her current situation.

I don’t think [teachers] need to always use our textbooks for things. And my colleagues are really into [thinking], “Oh, we need to read this section. And then we’ll take notes over it.” Well, what’s that doing? You’re just giving them the information for the test. You’re not really making them think about it. The kids have already learned that if I just do the study guide, I’ll pass the test. So I’m at the point of no study guide and I really don’t want to give notes. I’d rather just find another means to do it and get through the loopholes. But, we’re pushed by the administration to be very close in what we teach and how we deliver it. I mean, they check our grades to make sure we have the same assignments and stuff like that. And you know, I don’t always agree with the same assignments. But you’ve got to stay the same.

Our curriculum is totally based on the book. I’m [thinking], “It doesn’t have to be and it shouldn’t be.” . . . . And I got in trouble last year in my [teaching] evaluation from straying away from [the book]. I brought in some ethics into cloning. For seventh graders we did cat cloning and whether or not we should. And [students] did their own research pods and stuff. [The students] liked the idea of researching it. But because cloning wasn’t actually stated in the curriculum, I got nailed on it [in my evaluation].

Teacher F-1 identifies her colleagues and administrators as part of the institutional constraint she faces. She identifies another source to this restraint for conformity:

I don’t think it’s necessarily the administration. I think it’s the parents putting the pressure on the administration. I think parents are playing more of an active role than ever before. They really want to know what their students are doing and why they’re doing it. And [asking], “Why does my son have this assignment but my neighbor’s daughter—who’s in the other science teacher’s class—isn’t doing that kind of thing?” And so the administration [responds], “Well, we’ll make sure that [all students are] getting the same thing.” So I honestly think sometimes it’s just giving into the parents sometimes. Parents are really actively involved.

Although parental involvement is often helpful for students’ education, they can also have a role in institutional constraint.
Barriers notwithstanding, Teacher F-1 does reflect on her current state of teaching. She identifies areas for improvement, though her reasoning for making changes is stunted by devalued considerations for students’ learning.

Questioning is hard for me. But I’ve seen it takes time at the new school year to build them up to the behaviors you want them to exhibit. [Author’s note: These comments were made at an interview taking place after Thanksgiving break.] Especially with discussion. Especially with seventh graders. You have to remind them of the behaviors you want because you got them full of energy and they are just right out there with questions and stuff like that. And they ask you the most bizarre questions. And what I’ve realized is that ninth graders can handle sarcasm and I’m a sarcastic person. And I’ve realized sarcasm is not a good thing with seventh graders sometimes. And I’ve really worked on being patient and realizing that I can’t go as fast and you just have to slow down. And realizing that their questions are totally innocent. They’re not asking them [to get] attention or something. Like some kids will say just dumb questions. . . . But seventh graders are actually asking them because they’re curious.

Teacher F-1 learns from her experiences with students about the role of sarcasm. Her reflections on her interactions with students, though, indicate incomplete understanding of the value of using and drawing out student ideas. She knows that students’ questions are valuable and she works to show value. However, her attention to students’ actual thought processes is limited and procedural.

The biggest issue right now is handling the questions [students are] coming up with and still covering the materials that we need to cover that day. Like today, when we’re doing discussion, [students] had tons of questions. And I [answered], “Well, let’s get through what we’re talking about and answer questions later.” And I said, “Keep your paper out on your desk, right your question down, and we’ll answer questions at the end, or at the beginning of tomorrow. But we really need to discuss these matters first.” And that way, they can still jot it down and remember what they’re asking. And I’m still asking them questions.

Teacher F-1 describes how she eventually handles the students’ “weird” questions:

I said, “Well, I don’t really know how to answer that question. Right it down, we’ll think about it. And if we can’t figure it out, then we’ll Google it.” [laughs] So we always Google things to see. If I don’t have the answer, let’s see if we can find it somewhere else. So I think that’s helped. And the important thing is making sure I
go back to those questions the next day. Because . . . if you don’t, [students] think
their questions aren’t worthy or anything.

Teacher F-1’s mention of “doing” discussion indicates a perspective of routine schooling as
opposed to an in-depth discourse about ideas. Questions are to be answered, rather than
discussed and pondered. Finding answers does not include thoughtful investigation or
examination, but a quick internet search. This procedural approach to teaching also appears
in her focus on “covering” content just to get through it. Teacher F-1 repeats this attitude
when she reflects on her ideal classroom conditions.

I’m thinking of what I want to cover with [students] that day. And get to the point of
where I want to be with them by the end of the period. So that I know where to take
off the next day. And that’s really hard, to make sure that you get all the class periods
at the same point and what you want to accomplish for that day. You still have to be
flexible. If it doesn’t work, you’ve got to carry it over to the next day, which is fine.
If you think about your teaching . . . this is where I want to be by the end of the day.
And how am I going to get there? I’m thinking of the questions I want to pop at [the
students] to see what they understand and higher order thinking skills. And I can
target those kids . . . you understand what I’m doing because I popped you a question
and made it higher for you and you were able to answer it.

Teacher F-1 recognizes the danger of a tendency to “pop” questions at students too quickly.

Sometimes I’m just shooting them off, I’m just going and going and going and I’m
[saying to students with questions], “Okay, we’ll answer that in a minute but we need
to . . .” I guess I get that driven from my coworkers. You just got to a certain point.
Otherwise, I’d be off. And I would love to just sit around and talk with the kids. But
you’ve got those kids that are being off task, being mischievous or opening up the
windows, trying to do something. So trying to keep them on task all the time [is
crucial] with them. So if I keep them all together and on the same point and we keep
looking, we do good.

Management becomes a major concern when Teacher F-1 works with her students. She
views her interactions with students with respect to maintaining control of the class. Rather
than working to manage the classroom and promote thoughtful, engaged discussion, she sees
a faster question-and-answer pace as a means to keep students on task.
Teacher F-1 does mention her questioning when discussing her actions to improve her teaching. Most of her attention for improvement, though, hinges on finding better activities and curriculum.

I’m starting to be more aware of my questioning. At first I used to be really afraid of discussion. [I thought], “I don’t think I’m asking the right kind of questions and stuff like that.” So audiotapes have been helpful lately. . . . I have another teacher in my room 8th hour and she can check it for me at the same time. So that’s nice. I also have a teacher aid at the same class, so that’s helpful. Right now what I’d really like to do is [take the class] Restructuring Activities. I’ve said that over and over again. And so that’s one main concern. I’m excited because I get to be on the curriculum committee this year for science. And I like to look at what we can change and how it will best suit our kids at what we can do, like what curriculum we can bring in. I’d like to try the FOSS kits. I’ve heard those are really good. I think that’s the other thing. Curriculum wise, I think of my goals and how students learn, and what curriculum’s going to best suit students. . . . Because I think that curriculum that our students have right now is not really what’s best for them.

Teacher F-1 again puts value in external sources, whether it is a co-teacher or para-educator, a class, or curriculum materials.

**Artifacts**

The curriculum Teacher F-1 currently uses feature a litany of traditional materials and worksheets. “Study guides” are a list of short answer questions asking for definitions, examples, and vocabulary recall. These align directly to written paper exams, which feature sections of multiple choice, matching of names, true/false, fill-in-the-blank, definition and example short answer, and labeling parts of a diagram. Questions asking for extended, higher order thinking answers are rare and narrow. On the cells unit test, for example, the lone “writing skills” question reads, “Describe the process of photosynthesis and cellular respiration. Using complete sentences, please include all raw materials and products that each process holds (4 points).” Another unit test features the lone extended-answer question: “Explain how results that show a hypothesis to be wrong are just as important as results that
show a hypothesis to be correct.” Another assessment asks seventh-grade students to label fifteen human muscles. Teacher F-1 includes outline notes of her PowerPoint presentation for the unit of “Cells, cell processes, viruses, and bacteria.” This outline includes 27 PowerPoint slides that display terms and definitions, names, and summaries of historical science progress. None of the slides include blanks or questions that could engage students in critical thinking or assess ideas. The last three slides, though, do contain a 10-point quiz with recall multiple choice, true/false, and fill-in-the-blank questions. “Guided Reading” worksheets contain questions asking for definitions, lists, scientist names, and additional recall, with no critical thinking or application. Laboratory activities are textbook-based and have “cookbook” procedures. In a lab on measurement, students are told precisely what units and technique to use to find mass, length, and volume of various objects. When students are asked to convert units (m to cm, mL to L), they are also given the mathematical formula next to the data table. Student thinking about solving problems, identifying and collecting data, organizing results, and analyzing findings are all minimal, directed by the handout. Other labs feature step-by-step instructions for adding materials, measuring variables, recoding data, and repeating tests. Data tables are already given to students and questions are relegated to the “Conclusions” section, asking for evidence of changes, and content questions students could look up in a book without doing the actual lab. As Teacher F-1 referred to in her interview comments, she uses a cat cloning case study with her students. Materials in this project include a worksheet with questions asking for summaries of the provided articles’ content. This worksheet is copyrighted by an outreach coordinator through ISU’s Office of Biotechnology. Provided resources are web pages from two cloning biotechnical companies and one science magazine. One assessment piece of this cat cloning lesson is an essay
answering the question “In your opinion, is it ethical to clone cats? Why or why not?”

Students receive a handout providing step-by-step instructions for forming an essay response:

opening statement, details 1-3 and supporting statements for each, and a concluding statement.

Summary

Habits of Understanding: Teacher F-1 does show some understanding of what she should be doing as an effective teacher. However, most of this hinges on doing what she knows she “should” do. This is a moderately low (ML) match to the habits of understanding of ISU SSTEP. She mentions teaching to “get those higher order thinking skills” and “achieve what I want.” Yet, Teacher F-1 often seems to rely on outside forces to direct her teaching planning and practice, as opposed to her own research-framed decision-making. Furthermore, she focuses on “covering” material, “popping” questions at students to get an answer, with little attention truly given to students’ own thinking, including “bizarre” ideas. Disconnect between practice and some of her spoken awareness could be due a lack of passion and motivation to give the necessary effort for effective teaching. It could also indicate an incomplete understanding and development of these skills from Teacher F-1’s formal education studies.

Habits of Action: A review of Teacher F-1’s observed classroom teaching, shared anecdotes, and materials leads to a conclusion that her habits of action have a low (L) match to those promoted in the ISU SSTEP. Deficient classroom management is a major limit to Teacher F-1’s effectiveness as a teacher, also indicating minimal congruence with what is taught and modeled in ISU SSTEP. Her classroom practice is extremely traditional and aligned with the “game of schooling” disconnected to the reform, research-based framework
for science teaching she experienced in her methods program and, assumedly, her graduate studies.

**Habits of Reflection:** Teacher F-1 is quick to label institutional constraint as the primary reason for her current actions. She senses the pressure and disequilibrium with what she says she knows is effective instruction. However, she does not possess the passion, understanding, skills, or a combination of the above to do the work necessary to negotiate through these expectations. Her habits of reflection have a moderately low (ML) match to ISU SSTEP. Teacher F-1’s definition of “okay” is knowing her current state, her desired state, and how to move from one to the other. However, her plans for improving are all reactive dependant upon colleagues, curriculum or other outside sources. She holds minimal expectations for her own contributions to her change.

**Habits of Improving Practice:** Teacher F-1’s habits of improving practice also have a moderately low (ML) match to ISU SSTEP. Her current year’s goal is to improve her questioning. Teacher F-1 mentions using an audiotape to record her classroom teaching, a practice promoted in ISU SSTEP. However, Teacher F-1 does not indicate any use of an explicit tool such as a SATIC coding sheet to quantify and analyze her behaviors, a practice also taught in ISU SSTEP. Again, Teacher F-1 relies on others to steer her, such as a co-teacher or even a less qualified para-educator. Teacher F-1’s action plan is mostly reactive, depending on outside forces for improvement. This includes finding a better curriculum or waiting to take a class as opposed to being proactive and changing what she can with her activities and lessons.

**Overall Alignment of Habits with ISU SSTEP:** As an overall summary rating, Teacher F-1 has a moderate low match (ML) to the habits promoted in ISU SSTEP. It is
difficult to tease out influences from Teacher F-1’s undergraduate and graduate experiences at ISU. This study focuses on the former. Even so, consideration of Teacher F-1’s extended experience at the ISU SSTEP through her graduate experiences makes a starker mismatch between Teacher F-1’s habits and those promoted at ISU SSTEP. Teacher F-1 conveys awareness that she “should” use certain teaching strategies and behaviors, but this is not articulated in a manner that conveys complete understanding. Also, she notes goals reach beyond content knowledge, but her practice and strategies to promote these are limited and not congruent with some of her statements in the interview. Often, Teacher F-1 cites institutional constraints like time, lack of support, and standards as barriers to her desired state. These factors, though, are stated more as excuses to why she does not work to reach this ideal level, which is not completely articulated in a clear manner. Perhaps the most indicative portrayal of Teacher F-1’s current situation and practice is her door-sized poster at the front of her classroom that lists her dozen goals for students, items taken directly from her methods coursework and written research-based framework paper. Despite this prominent presence, most of the goals are ignored or overlooked during the actual lesson and teaching interactions. This typifies Teacher F-1’s surface awareness of the need to promote such goals and practices, but the lack of action, passion, and understanding of what it takes to promote and develop these goals. A moderate low match to ISU SSTEP results from her ambiguous reasons for decisions (fun, not being a lecturer), lack of consideration for students ideas (“dumb questions”), devalue of questions and discussion, focus on “covering” content, lack of management, and reliance on outside forces (curriculum, professor, class, colleagues, mandates, etc.) for improving practice.
Teacher F-2: 6th Year Teacher (Former Program)

Overview

Teacher F-2 is the biology and anatomy/physiology teacher in a small agricultural town. The 10th grade biology classes observed consisted of 13-19 students, all Caucasian. Teacher F-2’s school building uses a block scheduling format; he has his students in class for roughly 90 minutes. Perhaps due to this longer period, or perhaps due to Teacher F-2’s demeanor as a teacher, the classes observed had a slower, relaxed pace than other observed classrooms in traditional 45-minute periods. Teacher F-2 had a calm way of working with the students, even turning on quiet jazz music as the students work in their groups, projects, or on assignments. The class had no discipline problems, but students felt free to share their thoughts or offer a joking comment, as did Teacher F-2 in a relaxed, laid back tone. The non-intrusive, classroom management and comfortable environment was even more noteworthy in one of Teacher F-2’s classes, which contained a high needs student who was in the mainstream setting for the first time this year. Students were not rushed to complete a project or assignment in 45 minutes. Rather, they had time to discuss concepts in a peaceful atmosphere, void of a rushed feeling. This slower pace did seem to lower the interest and limit the engagement of all the students in the class. At times, half of the students appeared bored or disinterested.

Content, Activities, COP Coding

Each visit observed a class period broken into two or three major activities or lessons. One common activity was student presentations. Students gave presentations with a partner or group to the rest of the class by using PowerPoint or whiteboard notes. Topics included research projects and concepts out of the textbook readings. The extent to which students
truly understood and investigated these concepts is questionable, as some may simply have been copying from the textbook, other resources, or providing incomplete analogies. Even in these presentations, during which students could ask each other questions, most were quiet and simply seemed to be “going through the motions” of schooling. The first observed lesson, in which students presented on genetic diseases, included the greatest number of student questions, perhaps due to the application to family experiences. Evolution presentations in the third observation included signs of misconceptions such as Lamarckian evolution and evolution at an individual scale. In groups of three, students presented information on a term related to evolution. The rest of the class had to fill out a packet that featured a page for each concept. Presentations (and pages) were broken into sections: book definition, “my” definition, and a space to sketch an illustration representing this concept.

The textbook was heavily relied upon for both research and for readings, concepts, and homework. Other lessons included an activity requiring students to make a model of DNA with toothpicks and computer ribbon paper. This activity had potential for concrete representation of abstract concepts, application, creativity, cooperation, and deeper understanding. However, it was mostly a cookbook, craft activity in which students had to follow directions on a handout that told them how many toothpicks to use, what colors to represent the nucleic acids and base pairs. Furthermore, little attention was given to asking students how this model is not like the present understanding of DNA’s structure. Perpetuation or creation of misconceptions could have arisen from this activity since Teacher F-2 did not call explicit attention to such discrepancies.

As seen in Figure 5, COP coding is consistent across the three observations, with categories having medium to medium high scores. Students were frequently engaged in
investigating and sharing ideas. However, the amount of intellectual engagement was limited at times. Students seemed to “go through the motions” of doing work, picking information from the textbook, and presenting information without deeper conceptual examination. The third observed lesson is lower than the first two, as it included the greatest amount of focus on “book learning” without extended engagement in reflection of discussion of student ideas.

Teacher F-2’s limited number of questions asking for elaboration or clarification added to this lack of further investigation and conjecture. Not all of the students were engaged, and some could have passively slid through the lesson without participation. Others indicated they held misconceptions such as Lamarckian or individual evolution; these ideas were not actively drawn out or examined by either teacher or student. Several

![Figure 5: COP coding for Teacher F-2](image)

*Maximum Capsule rating is 8; all other categories have a maximum rating of 5*
opportunities arose to ask questions to foster discussion. Plentiful time existed for further examination of these ideas, as students had at least fifteen minutes for working on homework at the end of each lesson.

**Teacher Behaviors and SATIC Pattern**

Even with indications of student misconceptions, Teacher F-2 did not exhibit the habit of using examples or asking them questions for elaboration to draw out students’ ideas. He also did not foster much engaged discussion of ideas and concepts as students worked on their projects. Most of his interactions with students were about procedures. An underlying pattern of Teacher F-2’s interactions was “short circuiting” the lesson by giving students information or answering their questions, as opposed to asking students to elaborate of how they got their answers, share their ideas, problem solve, or think further about the concepts. This inhibited the ability to draw out and assess students’ ideas (including misconceptions) and limited the amount and degree of student engagement in learning.

**Questioning:** As seen in Figure 6, Teacher F-2’s initiatory behaviors included a significant amount of talking (28 incidents out of 82; or 34% of all initiatory interactions). Talking was evenly balanced between lecture (SATIC 1; 17% of all initiatory interactions) and statements/rhetorical questions (SATIC 2; 17%). The relatively high percentage of talking limited Teacher F-2’s ability to assess student understanding and increase engagement. During a review of monohybrid crosses, for example, Teacher F-2 would proceed through the process of finding phenotype ratios. As promoted through ISU SSTEP, an alternative to foster engaged thinking would be to ask students questions about each decision and thought process made in arriving at conclusions with the monohybrid cross.
Rather than telling, he could have asked students, “How do you get this combination?” or “How can you double-check your work?”

![Figure 6: SATIC coding for Teacher F-2 (block schedule)](image)

Teacher F-2 typically asked simple questions (72% of initiatory questions). Broken down among categories, these simple questions were dichotomous yes/no (SATIC 3a; 24% of initiatory questions) and short answer (SATIC 3b; 48%). The remaining 28% of questions were mostly thought-provoking (SATIC 3c; 20%) and extended-answer (SATIC 4, 7%). A total of only four SATIC 4 extended-answer questions were asked in three observations of 90-minute block lessons. The lack of open-ended questions (SATIC 3c, 4) of questions limited assessment and engagement even further than the amount of teacher talking.

Teacher F-2 did ask questions of the students when they presented their research to the rest of the class. These questions were aimed at the presenting group, mostly just asking their
opinion of the issue. For example, “Do you think we should let people know about their genetic disposition and possibility of diseases?” Such questions did not foster much discussion or thought by the presenters. They would often answer “maybe,” “I guess so,” or “I don’t know” to his questions. These post-presentation questions also did not engage the rest of the class to discuss these ideas or queries about concepts and applications.

**Responding:** As seen in Figure 6, Teacher F-2’s responses to students were almost entirely teacher-centered (SATIC 5, 7-10), making up 88% of all responses. The primary forms of responses were repeating student comments (SATIC 8; 21 incidents, 30% of all responses) and answering student questions (SATIC 10; 22 incidents, 32% of all responses). As stated above, he would ask some questions for elaboration during student presentations (SATIC 11; 5 incidents total). These questions were used for modeling listening and responding skills as much as they were for engaging the students in thinking and truly finding out their ideas.

**Non-verbal Behaviors:** Inappropriate wait-time I (SATIC 13a) was exhibited five times during the first observation, in which Teacher F-2 was reviewing monohybrid crosses and presenting dihybrid crosses. As stated earlier, the pace of the block schedule classroom was typically relaxed and slower, however, than a traditional 45-minute period. Teacher F-2 displayed warm and relaxed body language and facial expressions by smiling, speaking softly, and giving equal attention to students around the room. His quiet demeanor and large body frame, however, may have intimidated some students. Teacher F-2 would stand at the front of the class when leading discussions or presenting information. This often led to some students not paying attention and sitting quietly at their desks. Proximity of students by
frequently moving around the room was taught in ISU SSTEP as a way to maintain engagement of students and proactively avoid management issues.

During student presentations, Teacher F-2 would sit at the back of the room at an empty desk and not interrupt much as the students spoke. From this position, he would ask questions or inquire about the students’ opinions after their presentation. During student work, Teacher F-2 moved about the room, occasionally interacting with students. These interactions, though, did not display purposeful assessment or encouragement of engaged thinking about the concepts. Topics of discussion focused on procedures, assignment expectations, a question about the assignment that he would often answer (SATIC 10), and “small talk” about the upcoming school sporting event.

**Perceived Goals for Students**

In his on-line questionnaire responses, Teacher F-2 listed four goals he currently has for his students. The first two receive the most emphasis:

a) *Students will leave my class with an understanding of the scientific process (#2, #3, #11)

b) *Students will be able to apply their understanding of science to everyday topics and problems they may face (#4, #6)

c) Students will understand the involvement of science in current news media and government reports (#11, #12)

d) Students will be able to educate those around them relating to the scientific process (#3, #5)

Teacher F-2 had 50 students complete the goals questionnaire. As seen in Figure 7, four goals had an average ranking lower than 4 (“much”). These goals and their rankings are as follows. Goal #1: Students will convey self-confidence and/or a positive image (mean = 3.86, SD = 1.050); Goal #6: Students will participate in working toward solutions to local, national, and/or global problems (mean = 3.18, SD = 1.173); Goal #8: Students will be
creative and/or curious (mean = 3.70, SD = 1.182); and Goal #12: Students will demonstrate an awareness of the importance of science in many careers (mean = 3.92, SD = 1.027).

The student questionnaire data are supported by classroom observations, artifact analysis, and teacher interviews. In the block schedule format, students had to use their time wisely on projects and assignments. This was expected, though, and Teacher F-2 did not explicitly teach students ways and means to set goals and self-evaluate (Goal #8). Teacher F-2’s friendly interactions and choice of student-led projects promoted Goal #9 for students to convey a positive attitude about science. Presentation projects developed students’ ability to access and use resources (Goal #10), although this goal was promoted mostly though using the textbook or internet. Goal #3, nature of science (NOS) understanding was moderately promoted. Classroom posters, student presentations, and classroom discussions gave explicit attention to social and historical influences on scientists and their work. For example,
Teacher F-2 presented information about Rosalyn Franklin’s role in developing an understanding of DNA. Critical thinking (#2) and problem solving (#4) goals were inhibited through a lack of student-centered questions and responses and traditional memory-based assignments. The same is true for the goal of creativity and curiosity (#7), which was also impeded by some cookbook requirements for craft projects and presentations. Demonstrating a deep understanding of concepts (#11) was moderately promoted, as often students simply relied on the textbook for term definitions as opposed to focusing on overall principles and application. Furthermore, Teacher F-2’s interaction pattern limited his ability to draw out and discuss students’ ideas. Working toward solutions to local, national, and global problems (#6) and demonstrating an awareness of science careers (#12) were two goals minimally promoted in class observations and assignments. Some connection of these two goals was exhibited in the students’ presentations of genetic diseases, but the extent of exploration was limited.

**Interview**

When comparing on his practice and his experience through ISU SSTEP, Teacher F-2 expresses value to his research-based framework, but does not always reflect on its usefulness:

> I am very grateful for my RBF and I am glad its here and I benefit from it. But I really haven’t read it since I started teaching. It has just kind of sat there. I need to dig it out again. I am sure for things I am doing now, I don’t really remember.

Time may be an issue with respect to Teacher F-2’s difficulty remembering specific experiences from ISU SSTEP. He does note, “I don’t remember most of the things we did.” Whether due to six years of time passing or a lack of attention and reflection, Teacher F-2
had considerable disconnect from his ISU SSTEP experience. Teacher F-2 articulates his understanding about his goals for students and his aims for his teaching:

My base class here is just regular biology. And for some of these students . . . it may be the last science class they ever take in their lives. And I think it is the last chance to have them be sort of responsible citizens. They are going to hear news stories and they are going to probably in the future have to vote on issues involving science. It is the last chance to sort of educate them and make them responsible in that manner. I think that is important.

I know where I want to end up and I know the information I want given. That is kind of a first and foremost. I have an idea of the time I have. And a large part is how the class goes, what questions get asked. I allow myself to go different directions because I don’t plan lessons. The lesson plan that I was forced to write [in the ISU SSTEP methods course] was probably a good thing for me. But that was the last time I wrote one . . . when I took that methods class. My lesson plans are in my head and I know what I have to get done the next three days. I kind of go three days at a time and whichever direction today’s class takes me, that is fine. I go with it. I go where the students go, what they ask, what they are interested in . . . that takes care of that part and now I have this I need to get to the next day. And eventually it will come down to a day or two before we are done . . . we missed these things. Let’s go back and make sure we hit them before we close the unit and take a test. They are kind of open-ended ideas in my head. That is what the lesson plans are.

Note in the above statements that Teacher F-2 has notions of where he wants to take his students based on his goals, time allotted, and content. Although he does not specify drawing out his students’ current levels of understanding (including misconceptions), Teacher F-2 does work his lessons around student comments and interest, fitting in these “different directions” with respect to student questions. Contrary to ISU SSTEP—which promotes teachers having a constant conscious awareness of their decisions, Teacher F-2 seems to have slipped into a more unconscious teaching approach, perhaps due to his six years of experience.

When asked about his interactions with students, Teacher F-2 speaks mostly in broad terms.
I would like to think of [my classroom interactions] as casual conversation. A lot of times it depends on the day. There are days in anatomy when I simply lecture. There are days in biology when it is nothing but question and answer and I really don’t have control other than I am standing in the front. On an average day I would call it controlled casual conversation with my students.

About the content, materials, activities, and strategies that Teacher F-2 uses, he notes that “Everything is a compromise between what you would like to do and what you have to do.” Teacher F-2 speaks to the general tone of the class, but does not explain his rationale for choosing one behavior or the other, such as the reasons for direct instruction versus classroom discussion. Much like his reflection of his current state of teaching, Teacher F-2’s description of an ideal state also typifies this generalization:

In my ideal situation, [students] are interested in something they are asking about. I just kind of prompt them along and they go do the work. They go figure it out. They tell the rest of us how it works or what the answer is. A lot of times they want answers from me and I don’t do it often . . . A lot of times I would like to be better at [saying], “Good question. You go find out and then you come back and tell us or let us figure that out right now.” That type of thing. And I don’t get to do that enough, basically . . . let them dictate what we do.

Teacher F-2 offers no suggestions for how he could work to increase these preferred types of interactions with the students. When asked what he currently does to improve as a teacher, Teacher F-2 focuses mostly on activities and projects. Like his reflection, Teacher F-2’s action plan is feasible but mostly ambiguous.

I keep implementing more every year. I add a little bit more student-driven stuff. It’s not class stuff, but it’s projects that they choose . . . They do all the research that they come and present to us. I now have my anatomy students doing case studies where I give them a situation and they have to figure out what is wrong and present. I guess I am doing a little big more of [asking], “Hey, what do you want to do? And you go do it . . . find out and come back and tell us.” I am getting a little bit more of that. But it’s not enough. Those are our projects, not our everyday class type of thing.

As the only full-time biology teacher in his school, Teacher F-2 notes that he has the trust from his administrators and the freedom to teach according to his own discretion: “My
administration has been great. I am allowed to teach whatever I want to. There has been no
corralling me there.” However, Teacher F-2 does mention his school features some barriers
that do not match his framework for teaching:

I have a huge problem right now with our staff development. For [this year, it] is
CRISS. . . . I am kind of in this argument. That [I use] research-based activities and
they want me to knock down what I have built up. Mine is all student and inquiry-
based learning. So they want me to tear down some of the things I am doing in order
to incorporate their specific CRISS lesson plans. So I have to turn in CRISS lesson plans. . . . But every time I do that I have to kind of tear down the framework of my
classroom that I have built. Very irritating. I understand where they are coming from
and the strategy is actually very useful. But I think my way is very useful too,
effective for a science classroom.

Part of Teacher F-2’s perceived constraint may be due to his usual practice of not writing
down his lesson plans. Nevertheless, a barrier to his teaching exists. In addition to constraint
from an institutional level, Teacher F-2 also experiences a unique form of resistance from
one of his colleagues.

One of my co-science teachers—a chemistry/physics guy—is very anti-evolution and
has made that known to me. [He] teaches basically that creationism is science-based
to some group of children during the summers. . . . Of all the people, it’s a fellow
science teacher. That just drives me nuts. . . . He is adamant. He brings me videos. I
have a DVD at home that I am supposed to watch. The title of it is Thousands Not
Billions or whatever, scientific proof that the earth is 15,000 years old or something.
So he is constantly bringing me things like that and telling me I’m wrong. So that is
very difficult to deal with as someone who is supposed to be a science colleague in
the room right next to me.

Teacher F-2 mentions that he has some students and parents that resist his teaching of
biological evolution, but none are usually a problem. He cites his experience in the Nature of
Science graduate course at ISU as helpful in dealing with the evolution issue. His inclusion
of NOS topics in the classroom lowers students’ initial barriers. However, his colleague
remains, as Teacher F-2 describes it “a thorn in my side.”
Artifacts

Teacher F-2 uses a mixture of assignments and projects in his biology and anatomy classes. Biology class features worksheets from the textbook publisher along with original handouts from the teacher. Textbook handouts and exams have traditional tasks such as fill-in-the-blank, short answer compare/contrast, multiple choice, and labeling of diagrams. Original teacher-created handouts feature short answer questions, analysis, practice, and application of concepts and skills such as Punnett squares, DNA sequencing, Hardy-Weinberg equilibrium. Many of these activities foster more open-ended application of concepts. Some questions include teacher-directed “hints” such as “be sure to have labels” and other statements after questions, for example: “What are the possible types of gametes that I can get out of plant A? (hint: these are the gene combinations that go along one side of our Punnett square)”. Such assistance may actually limit student problem solving and critical thinking. Some projects (such as the DNA model described in class observation) have some creativity component, though students mostly have to follow directions to complete them. Materials also include several journal and internet articles related to contemporary biology-related topics such as stem cell research, diabetes, and vaccinations. Some of these include questions for completion and discussion, provided by the resource. Questions are open-ended and short-answer, and many are recall from the article. In an internet article about stem cells, questions include: “What is a stem cell?” “How do adult and embryonic stem cells differ?” “What are some major concerns with adult stem cell use?”

Student presentations are a frequent component of Teacher F-2’s classes. Students are given the following description about the presentations in class handouts:
Your group presentation is meant to be a supplement to the material you would normally be exposed to in this class. Your goal is to inform your fellow classmates about your topic. When finished you should have given your classmates thorough information, as everything you present will be fair game for the unit test.

Other criteria given in the guidelines include a PowerPoint presentation between 24 and 30 minutes, visual aide, preparation for a question and answer time from the class, a typed outline of the presentation, questions and answers for inclusion in the upcoming test, and a typed evaluation of group members (including self). Students are encouraged to “Take advantage of this opportunity to do something that interests you and your classmates.” A rubric for scoring the group presentation includes categories about comprehension, group dynamic, time limit, preparedness, clearly speaking, and posture and eye contact. Traditional written assessments include a textbook publisher test with fill-in-the-blank, term compare/contrast, and multiple choice questions. Such written exams have limited engagement and assessment of students’ deeper understandings of fundamental concepts.

Summary

**Habits of Understanding:** Teacher F-2’s habits of understanding have a moderately low (ML) match to ISU SSTEP, as he puts some emphasis on his goals for students beyond science content and basing decisions on students’ ideas. Still, Teacher F-2 does not recognize importance in explicitly writing down questions, examples, etc., he can use with his students to help them make correct connections. This hinders the impact of his questions and interactions. Furthermore, his lack of questioning to students both in presenting and responding indicates a lack of attention to the importance of drawing out students’ understanding (including misconceptions) and engaging them in thinking about their ideas.
**Habits of Action:** Based on classroom observation, interview, and artifact analysis, and more, a designation of moderately low (ML) match has been given to Teacher F-2 for his habits of action. Teacher F-2 has consistent medium to high marks on the COP rubric for science inquiry and student engagement. Though Teacher F-2 does emphasize student thinking as a guide for his decisions, he also does not write out lesson plans with questions, examples, and illustrations to explicitly help students make connections from their experiences to accurate understandings. His SATIC pattern contains a high percentage of teacher-centered responses (praise, answering questions, repeating questions, clarifying or interpreting student comments). His initiatory behaviors are mostly talking and simple questions (yes/no, short-answer), with some occasional open-ended questions. Materials are a mix of traditional textbook worksheets and more open-ended, project based handouts. Assessments are more than textbook publications, though, including student presentations and group projects. Some of these, however, are limited in their promotion of student goals such as critical thinking, creativity, and self-evaluation. Students can easily play the “game of school” in many instances, with limited intellectual engagement.

**Habits of Reflection:** Teacher F-2’s habits of reflection are a low (L) match to the ISU SSTEP, as he shares his thoughts in general terms. A lack of precision in language exists in his discussion of his current state and desired state. He knows about the strategies and behaviors he uses to promote successful science learning, but his description of these are ambiguous. Teacher F-2 identifies areas for improving practice, but these strategies fall along the general lines of “self-improvement.” He lacks specific attention to particular tasks he could take to immediately monitor and improve his classroom interactions with students. Ambiguity also appears in Teacher F-2’s description of his ideal state. Rather than talking
about specific actions exhibited by teacher and students, Teacher F-2 talks of students being “interested in something” and then going to “figure it out” with the teacher’s prompts. Teacher F-2 does not articulate the type of behaviors he does to guide students along this course of learning.

**Habits of Improving Practice:** Teacher F-2’s habits of improving practice are also a low (L) match to those promoted in the ISU SSTEP. He tries new things, but most are activities and projects. Absent are self-monitoring and practicing of his teacher behaviors, collaborating with colleagues, and actively attending and presenting at conferences. With respect to his experiences with staff development CRISS strategies, Teacher F-2 is mostly resistant rather than actively seeking collaboration and positive benefits from communicating his ideas with colleagues. This resistance does not reflect the qualities of a science education leader, as promoted by ISU SSTEP.

**Overall Alignment of Habits with ISU SSTEP:** Teacher F-2’s current professional practice and understandings have an overall moderately low match (ML) to the ISU SSTEP. Teacher F-2 does display some active and thoughtful behaviors promoted by ISU SSTEP. For example, he enrolled in the Nature of Science course as a graduate of the ISU program. Teacher F-2 did not take this class during his time in the former program. This practice of enrolling at a graduate-level science education course indicates a closer match to the habits of ISU SSTEP. His inclusion of NOS instruction in his class, therefore, is not a product of his time in the former program. Rather, it is a result of his active effort to improve and learn as a teacher. Teacher F-2 has the longest tenure as a teacher among the participants in this study. As a six-year veteran, Teacher F-2 has perhaps lost some of the conscious competence promoted by the ISU SSTEP. He displays some habits of action and understanding promoted
in the ISU SSTEP, but also lacks key and consciously aware components, resulting in a
moderately low overall match.

**Teacher F-3: 4th Year Teacher (Former Program)**

**Overview**

Teacher F-3 is in his fourth full year of teaching, although he was observed in his first
year at his current school. Prior to this year, he taught three and a half years at another
suburban school on the other side of the city. He teaches two courses: Chemistry; Anatomy
and Physiology, both of which he taught at his previous school. Teacher F-3’s current
schedule involves block scheduling with 1 hour, 45 minute classes. Management was not an
issue in the classroom, as students were quiet, respectful, and reserved. The level of student
engagement, however, was low for typically half of the classroom. On average, half of the
students were quiet to the point where they did not actively engage in the discussion or
learning.

**Content, Activities, COP Coding**

Teacher F-3 displayed extensive organization and planning in his lessons. Students
followed an orderly lesson design, with activities requiring approximately 20 minutes each.
The variation broke up the extended block period so that students did not have excessive time
on one task. Components of the class lessons included lecture and PowerPoint note-taking,
guided and independent practice using equations and calculations, class discussions about
content and readings, hands-on activities, and more. These involved a variety of mixed
groupings and interactions. Teacher F-3 was always in control of the class sequence and
progression of activities. Labs and activities, therefore, were noticeably structured by the
teacher and featured little or no input or decision-making required of the students. This
In two of the three observations, Teacher F-3 took time during the class period to have students read and discuss readings about the history and nature of science. For discussion, he had the students move their rows of desks to form a circle around the room and have students face each other. He told them he wanted them to lead the discussion as soon as he asked each question in the review of the reading. Some students participated and Teacher F-3 remained silent as they took turns to share and discuss ideas with each other. Students’ ideas were challenged and used in the discussion. After a time for student sharing for a particular question, Teacher F-3 would then summarize key points. During other
discussions or activities, however, Teacher F-3 typically made conclusions and consolidation of ideas without student input. Science was seldom portrayed as inquiry, dynamic, and conjecture. The three observations occurred at the beginning of a semester and of the new block course. Hence, much of the science content was fundamental; yet it was portrayed in a disconnected arrangement. In one class period, students moved among scattered content, from phase changes to isotopes to factor-label conversion calculations.

One case of investigation was a “black box” activity in which Teacher F-3 presented a closed cardboard box with an unknown object inside. Teacher F-3’s challenge to students was creating a method to identify of the box’s contents without opening the container. Most students were engaged in this discussion. However, students sat passively in their chairs while Teacher F-3 performed all of the tests to investigate the box. He would shake the box and roll it in his hands. He also measured the mass of the box and reported this value, as opposed to having a student or group of students perform this task. Students suggested inserting other objects in the box to compare with the unknown object. Teacher F-3 used this idea and removed the unknown object in a nearby closet out of the students’ field of vision. He then proceeded to take objects donated by students (a shoe, sandal, etc.) and performed all of the tests with this new object. A degree of unknown existed, but all inquiry led to the teachers’ final objective. Furthermore, Teacher F-3 was typically the center of the action and investigation. Students were the audience. As a result, a majority of students are not actively or intellectually engaged in the learning. The discrepancies between Design and Implementation in the first two observed lessons are shown in Figure 8.
Teacher Behaviors and SATIC Pattern

Questioning: Teacher F-3’s teacher-student interaction pattern included a habit of calling on students by name throughout the lesson. He used this technique for roughly 90% of his questions. This may have been an attempt to keep students engaged in learning, or at least to make them pay attention. Again, the teacher was the controller of the knowledge. In this setting, students are less likely to participate because they want to and are engaged in learning, but rather because they have to and are playing the game of “schooling.”

As seen in Figure 9, over one third of Teacher F-3’s initiatory behaviors include lecturing or giving directions (SATIC 1) to students. This talking accounted for 38% of Teacher F-3’s initiatory behaviors. Teacher F-3 could have reworded these instructions or statements to questions that addressed the same information but encouraged students to share
their own ideas. All too often, though, Teacher F-3 relied on himself to articulate expectations, connections, and procedures. Of the 123 initiatory questions Teacher F-3 asked during the three observed lessons, 92 incidents (75%) were simple questions, either yes/no/dichotomous (SATIC 3a) or short-answer (SATIC 3b) questions. Only one fourth (25%) of Teacher F-3’s initiatory questions were open-ended thought-provoking (SATIC 3c) or extended-answer (SATIC 4) questions, those that the ISU SSTEP teaches its graduates to use a majority of the time.

**Responding:** Teacher F-3’s primarily responses to student comments or questions were teacher-centered (SATIC 5, 7-10). Out of the 134 teacher-centered responses used in three classroom observations, 76 (57%) were repeating student comments (SATIC 8). This habit of repeating student comments occurred consistently across regardless of the classroom activity—lecture, review, exploration, discussion, etc. Many of these responses could have been reworded to asking for elaboration (SATIC 11) or using the idea (SATIC 12), which could draw out students’ ideas and promote further discussion among students. Student-centered responses (asking for elaboration, SATIC 11; and using student ideas, SATIC 12) occurred only 19 times during the three observations of block-schedule classes. These responses (promoted by ISU SSTEP to be the primary form of responding) account for only 11% of all of Teacher F-3’s responses. Teacher F-3 also used the value-neutral response of acknowledging student comments (SATIC 6), which accounted for 24% of all responses. This response, however, was phrased as “okay” or “all right” and also became an annoying mannerism (see below).

**Non-verbal Behaviors:** Teacher F-3’s overuse of words like “okay,” “all right,” and “kay?” became an annoying mannerism as he acknowledged student comments or asked
rhetorical questions after statements. Inappropriate wait-time occurred 12 times during the three observations, including 5 incidents of inappropriate wait-time I (13a) and 7 incidents of inappropriate wait-time II (13b). Much like Teacher F-3’s habit of repeating student comments, his inappropriate wait-time I and II impeded the extent to which students could think and contribute to class discussions. Teacher F-3’s relationship with his students was pleasant, yet formal and distant. His body language displayed the most comfort when standing at the front of the room. He would walk up and down the aisles between desks occasionally when he lectured or led guided practice. During group work in the lab area, Teacher F-3 moved from station to station and interacted with students. The most engagement Teacher F-3 displayed was when he sat in a desk in the class circle for discussion of the NOS short stories. He did not maintain extended eye contact with students, and focused often on the materials in his hands such as a paper or object for demonstration. Teacher F-3 rarely smiled or joked with the students. His quiet demeanor did instill comfort and respect in the classroom. However, some students may have been intimidated by these same behaviors, as well as by Teacher F-3’s habit of calling on specific students by name.

**Perceived Goals for Students**

In the on-line questionnaire, Teacher F-3 reported five goals he currently has for students. Three receive the most emphasis:

a) Students will develop an interest in science (#9)
b) *Students will not settle for mediocrity (#8)
c) Students will make connections to science and their lives (#12)
d) *Students will develop critical thinking and problem solving skills (#2, #4)
e) *Students will exhibit traits of an educated, well-intentioned citizen (#5, #6)
Teacher F-3 gave goal questionnaires to students in his two chemistry and one anatomy and physiology courses (46 students). Like other teachers in the study, the two goals with the lowest average ranking were Goal #6: Students will actively participate in working towards solutions to local, national, and global problems (mean = 3.46, SD = 1.026) and Goal #12: Students will demonstrate an awareness of the importance of science in many careers (mean = 3.50, SD = 1.027). These were also the only two goals that had average rankings lower than a “much emphasis” (4) ranking on the student questionnaires.

![Figure 10: Student goals questionnaire results for Teacher F-3 (N = 46)](image)

The student responses are consistent with other data collected from observations, artifacts, and interview. The two goals with the lowest average ranking by students were among the goals with little or no promotion in Teacher F-3’s classroom: participating in working toward solutions to local, national, and/or global problems (#6); accessing, retrieving and using references (#10); demonstrating a deep understanding as opposed to
isolated facts (#11); and demonstrating an awareness of science in careers (#12). The latter goal was addressed through one brief lecture and PowerPoint show about the role of isotopes in medical bone scans (third observation). However, Teacher F-3 gave little effort to explicitly address how these concepts related, merely mentioning this connection in passing with two pictures pasted onto PowerPoint slides. This connection to careers may have been explicit, although the lecture format did not encourage to students actively investigate these links.

The interview and other communications with Teacher F-3 indicate he is aware of the importance for students to be critical thinkers (#2), creative and curious (#7), self-evaluative (#8), and problem solvers (#4). But he often short-circuits these goals by relying on his own statements or efforts to make connections in the learning or do the work in the investigation of ideas. For example, in a discussion about states of matter, Teacher F-3 told the class that a gas has no definite volume and no definite shape. Next he asked the students, “How would you put that in your own words?” This task was difficult, as many students had just received a succinct, useful definition from Teacher F-3. In fact, when Teacher F-3 asked one student how he would describe a gas, the student answered that it was obvious, referring to Teacher F-3’s shared definition.

Through his interactions with students, Teacher F-3 did extensively promote goals of self-confidence and a positive self-image (#1); a positive attitude about science (#9); and effective communication and collaboration skills (#5). History and nature of science (#3) was explicitly promoted through the historical readings and discussions. Students struggled with NOS concepts and their application to the current content knowledge. For example, even after reading the narratives, some students conveyed misconceptions about the
“invented” nature of science knowledge, confusing this creative component to inventing technology. Cookbook labs and models also perpetuated some misunderstandings of science. Such occasions would have been ideal for the inclusion of concrete examples of NOS concepts. An example would be a decontextualized puzzle for invented knowledge or explicit questioning about how models are not like reality. Instead, Teacher F-3 addressed NOS through the reading assignment without connection to the students’ own investigations.

**Interview**

When asked about his experiences in the ISU SSTEP science teaching methods course, Teacher F-3 alludes to his research-based framework (RBF) paper as being most beneficial. He speaks to the value of the RBF paper:

> [It has] given me the direction of where I want to take my teaching and kind of the stuff to back up why I do what I do. And that is one of the things that I feel is very important with teaching. If I am going to teach something, the methods I use I should have a reason why I use them.

Teacher F-3 again refers to his research-based framework when describing how he goes about planning and teaching a lesson. He goes further to explain how his experiences in schools have also shaped his approach to the classroom.

A lot of things started from my RBF ideas . . . and now a lot of it is the same thing. [My planning] hasn’t really changed a lot, but a lot of it has actually come out [of] high school reform, the idea of rigor and relevance. And so when I take a look and I am planning . . . I am trying to find the relevance. Especially with chemistry, when we are talking about a lot of stuff, a lot of [concepts] are abstract ideas and . . . [I try] to make it relevant to the students. Because if they are going to take an interest in it and if they are going to learn it . . . most students need to see the relevance to them. What is the purpose of them doing it?

I also take a look at the two classes that I teach [chemistry, anatomy and physiology]. I see them as classes that are preparing students for higher education. And so I take a look at the rigor part of it and I say, “All right, what are some ways that I can help them become better students not necessarily just to learn chemistry or anatomy and
physiology but to also help them out in other classes?” I try to figure out what are some skills that we can work on throughout the unit or chapter.

Most of Teacher F-3’s emphasis is on goals for students, including skills and characteristics useful to them as future citizens and ongoing students. Teacher F-3 explains role his goals have in the classroom:

What makes them important is kind of the goal of education. I mean, what is education all about? I think probably my most important goal not even related to science is just developing concerned citizens, citizens that are concerned about those around them and are conscious about not only those around them but other things around them. So that is how I justify it . . . I teach [students] what education is all about.

While goals for students are a high priority in Teacher F-3’s teaching, his consideration of research on student learning and appropriate strategies is mostly absent. In the above descriptions of lesson preparation, Teacher F-3 notes the importance of making chemistry content relevant to his students’ lives. However, he does not explain how research on learning informs this decision, as taught in ISU SSTEP. For example, he does not acknowledge the prior knowledge (and misconceptions) students bring to the learning experience, the importance of concrete experiences for learning these abstract concepts, the value of social interactions and discussions, and the role of practice in learning science skills. Teacher F-3 also leaves out any consideration for his role in classroom instruction, such as the behaviors he will use (questions, responses, examples, non-verbal behaviors, etc.) to foster engaged learning. His reference to activities is minimal and does not address the role of experiences, choice of materials, general strategies, or determination of appropriate content, all of which are essential pieces to the research-based framework promoted and modeled in ISU SSTEP.
Teacher F-3 does show some consideration for the teacher’s role in the classroom, as evidenced in his reflection. When asked about his interactions with students, Teacher F-3 identifies his tendency to ask yes/no and simpler questions (SATIC 3a, 3b).

I would say that I try to ask thought-provoking questions. I have caught myself turning my thought-provoking questions into yes-no questions. It is one thing I have thought about quite a bit. This last year I have asked the associate principal here who is doing my evaluation to look at that one thing in my teaching. I feel that it is one thing that is probably lacking a little bit in my teaching. I don’t think as much about it now and so I think a lot of my questions come off as yes-no questions a lot more than I would like I would say.

Teacher F-3 cites his goal for students to be critical thinkers as a reason for changing his questioning pattern.

It goes back to my goals, getting [students] to think critically. If I can ask the questions to get them to think critically, I know I am meeting that goal. A lot of times when I am asking students questions, I am struggling to get them to think critically. A lot of times they are looking for that yes-no question, and I think that is part of what is drawing me back into asking more yes-no questions than I want to—instead of getting the students to actually think critically and using some questioning strategies in order to get them there.

Like other teachers in the study, Teacher F-3 experiences student resistance to his open-ended questions. His allusion to “questioning strategies,” however, focuses only on increasing thought-provoking questions with no description of how he will do this. In addition to thinking critically, Teacher F-3 would also like to increase the quality and quantity of classroom discussions.

A goal area throughout my teaching—and I have done some improvement but I would say I am not where I want to be at yet—is the area of class discussion. Kind of where the students are discussing it where I am not giving them information. And having the students actually give almost all of the input. I think the area I would like to improve there is when we are going through some content and at the end discuss how can we cover content and include discussion. That would be probably the major area I would like to improve on.
Beyond asking more thought-provoking questions, Teacher F-3 does not share any further strategies for improving classroom discussions. As observed in his lessons, Teacher F-3’s, current lessons are typically teacher-dominated. He does not consider his other behaviors that may impact the level of interactions. For example, ISU SSTEP taught about questions as well as responses, non-verbal behaviors (facial expressions, voice tone, proximity to students), and wait-time. Teacher F-3’s consideration is limited to questions.

Requesting his associate principal’s monitoring and input is one action for improvement. Teacher F-3 admits to not recording himself (audio or video) at all in the school year of this study’s observations. He does exhibit some habits of improving practice, as he describes below:

Actually, a lot of time I refer to some resources that I have gathered over the years. Books from Marzano—I actually refer to those probably on a weekly basis, looking for a different strategy to try to improve. So what are some different ways I can do note-taking? What are some different ways we can do to refine some of that knowledge and organize the content in the student’s head? So I would say that would probably be my other major area I am trying to improve—just by using those resources.

Teacher F-3’s actions for improving practice focus mostly on strategies and activities. These are important pieces of research-based science instruction, but pieces nonetheless of a much wider spectrum of components, as taught in ISU SSTEP. Teacher F-3 does exhibit additional habits of improving practice through his coursework in graduate classes. He plans to finish his master’s degree in education administration. While these studies may not have complete and direct links to his classroom teaching, Teacher F-3’s efforts do represent the habits of a teacher leader, which ISU SSTEP works to create in all of its graduates.
Artifacts

Teacher F-3’s materials mirror teacher-centered instruction exhibited during the classroom observations. For example, in a chemistry lab testing for metal ion colors in flames, students are given a step-by-step “cookbook” procedure for their activity. This directive decision may arise out of safety concerns; however, students are not given any questions among the instructions that could engage them in thinking about their ideas. Furthermore, students are given a data table for recording their results. This hinders goals for creativity, problem solving, and communication skills. Safety concerns aside, Teacher F-3 still could have asked students to create their own way of recording and displaying their results to promote more than simple data collection and instructional obedience in his students. The data table given to students also displays three columns labeled for three trials (#1, #2, and #3) for each tested compound. Students would perform three tests by following directions, without any conscious consideration as to the purpose for these repeat tests. Some projects do foster more student creativity and critical thinking. For example, Teacher F-3 gave his students the following scenario:

Since it snowed and I had ice on my sidewalk, I spread a mixture of salt and sand on the concrete. To my dismay, the salt in this mixture caused damage to my sidewalk. Since I do not want to purchase anymore sand, you are responsible for separating the two. Not only do I want to keep the sand for future ice storms, but I also want to keep the salt to make ice cream. You need to develop a procedure to collect both products. You will need to include the following areas: procedures, data, calculations, conclusion.

This assignment is open-ended and fosters student engagement and investigation. Students also apply concepts to their real world. An anatomy and physiology project that includes application is that has students identify superficial and deep muscles by providing a massage for a parent/guardian. As students perform the massage, they are instructed to describe both
the action and the origin and insertion of each highlighted muscle. This activity promotes hand-on experience with the content, a research-based strategy promoted by ISU SSTEP. Teacher F-3’s assessment, however, mostly focuses on memorization of concepts and recognition of terms. An anatomy and physiology test, for example, includes 26 multiple choice questions on a 32-item test. The six non-multiple choice questions are mostly short answer and recall, for example: “List and describe the stages of cancer,” “Describe three possible uses for stem cells, including problems facing each use,” and “Why is understanding transcription and translation essential for stem cell tissue transplants?” Students receive a mixed message from these materials. Some of Teacher F-3’s lesson activities develop multiple goals and reflect research on how people learn. Assessments, though, promote content memorization and limited application.

Summary

**Habits of Understanding:** Teacher F-3’s interview responses indicate significant gaps between his habits of understanding and those promoted by ISU SSTEP. He does address the importance of having and promoting goals for students beyond content knowledge. Teacher F-3 also alludes to the value of teaching content with relevance to students’ lives. However, he lacks articulation on how to achieve this, including an absence of the role of research on how people learn and the role of the teacher’s behaviors in the classroom, all critical aspects of the ISU SSTEP. For these reasons, Teacher F-3 has a moderately low (ML) match to the program’s promoted habits of understanding.

**Habits of Action:** Teacher F-3’s habits of actions have a moderate match (M) to ISU SSTEP. Teacher F-3 does exhibit careful thought into his sequence of lessons. In the 105-minute block format, Teacher F-3 broke up the time with 15-20 minute activities. However,
most of these were teacher-directed with limited promotion of goals beyond content and following instructions. Analysis of Teacher F-3’s teacher behaviors and SATIC interaction pattern indicate a teacher-dominated classroom. While ISU SSTEP promotes the teacher’s critical role, it also models the habits of encouraging, valuing, and using student contributions as central to the learning process.

**Habits of Reflection:** Teacher F-3 does show some consideration for the teacher’s role in asking appropriate questions, as evidenced in his reflection. He also displays further reflection in his experiences as a teacher, including recognition of his questions and their impact on student engagement and classroom discussion. However, Teacher F-3 misses several components promoted in ISU SSTEP, such as wait-time, responses, non-verbal behaviors, and considerations of research into how people learn. This results in a moderately low (ML) match to the habits of reflection promoted and modeled in ISU SSTEP.

**Habits of Improving Practice:** Teacher F-3’s habits of improving practice—like his other habits—have significant absences compared to what was taught in ISU SSTEP. For example, Teacher F-3 does not record himself or even consider its value in helping him ask more thought-provoking questions and fewer yes/no questions. Instead, he relies on his associate principal’s feedback. Inclusion of administration in improving practice is indeed useful, but not nearly as effective by itself. Teacher F-3 does report habits of weekly reading published resources about teaching strategies and lesson planning. Again, the role of the teacher is mostly overlooked. The decision to take coursework in education administration does indicate habits of a teacher leader, which ISU SSTEP seeks to create in all of its graduates. This pursuit, however, was admitted by Teacher F-3 to have been initially motivated by an increase in income, followed by a deeper consideration for having a greater
impact on education. Teacher F-3’s habits of improving practice in his classroom neglect monitoring and practicing teacher behaviors. Therefore, it is apparent that Teacher F-3 has a moderately low match (ML) to the habits of improving practice in ISU SSTEP.

**Overall Alignment of Habits with ISU SSTEP:** All of the above lead to a moderately low (ML) match between Teacher F-3’s overall habits and those promoted by ISU SSTEP. His classroom instruction and artifacts are highly teacher-centered and often traditional, with potential for modification to more closely reflect research-based science instruction. Although Teacher F-3 does reflect and take action for improvement, most of this is from a managerial perspective and disconnected to research on how people learn and the teacher’s role in the classroom, which are key components of the ISU SSTEP.

**Teacher F-4: 5th Year Teacher (Former Program)**

**Overview**

Teacher F-4 is a fifth-year teacher in a unique situation for this study. During the school year of this study’s data collection, Teacher F-4 had to take a long-term medical leave of absence from her teaching position at the semester break. Data collected from Teacher F-4 include one lesson observation, the on-line questionnaire, the interview, and classroom artifacts, and student goals questionnaires she gave her students after returning from her medical leave. Teacher F-4 had been teaching 10th grade biology and 11th grade chemistry courses. Her school is located in a town roughly 10 miles away from a metropolitan area. In the coming decades, this town may soon become a suburb. The school building and atmosphere have a small-town feel, though hallways are confined and crowded in passing periods. Teacher F-4’s biology classroom had 24 students, sitting at tables of 3-5 at the front
portion of the room. The laboratory section comprised the second half of the room. Students were equally balanced with regard to gender, and nearly all were white.

**Content, Activities, COP Coding**

The observed classroom lesson kept the students physically active, although roughly half of the students exhibited limited mental engagement toward the actual concepts and applications. The lesson was a food chain and food web activity requiring students to don nametags of various animals, plants and other organisms. They then had to decide in their small groups (4-6 students) the order of consumption. After small group interaction and discussion, the class as a whole compared their group sequences, with Teacher F-4 asking some questions (discussed below) to foster discussion. A similar activity occurred later using a web model for the organisms. The discussion did not involve all students, which afforded some to easily sit back and be quiet, disengaged from the learning. Nevertheless, those students that contributed to the class discussions generated ideas and summaries about the relationships between organisms. Science was presented as dynamic and inquiry-based. Teacher F-4 did move into direct instruction when she presented names of the types of consumers: carnivore, omnivore, herbivore, detritivore. During this portion of the lesson, Teacher F-4 asked for some student input, but also spent considerable time lecturing to students (see below in *Teacher Behaviors and SATIC Pattern*). Consolidation of ideas occurred as students shared ideas, although some did not present their ideas in respectful tones or offered jokes for their friends. Planned assessment was mostly nonexistent in formal form. Teacher F-4 listened to students’ ideas, but a lack of investigative science existed when it could have been drawn out of students’ questions and comments. All of the above
lesson traits resulted in relatively consistent and moderate ratings across the categories in the COP coding (See Figure 11).

![Figure 11: COP coding for Teacher F-4](image)

*Maximum Capsule rating is 8; all other categories have a maximum rating of 5
**Teacher F-4 could be observed only once due to a medical leave of absence.

Teacher Behaviors and SATIC Pattern

Despite some students’ disrespectful tone, most were well-behaved, with light-hearted interactions with each other and Teacher F-4. The handful of disrespectful students (mostly male) mostly enjoyed sharing comments for the merit of humor and attention. Otherwise, the students in the class were mostly managed, if not entirely all engaged in thinking and sharing their ideas. Teacher F-4 did use some questions in a punitive tone to get some students’ attention and discipline.
**Questioning:** As seen in Figure 12, Teacher F-4 used a variety of questions (examples given below) during the lesson’s group activities and large class discussions. However, a majority were yes/no/dichotomous (SATIC 3a, e.g. “Can someone tell me what a herbivore is?”) and short-answer (SATIC 3b, e.g. “What is being transferred?”). These two types of questions constituted 72% of Teacher F-4’s initiatory questions (28 out of a total of 39). While these questions are appropriate in certain contexts, the ISU SSTEP promotes the habit of asking open-ended questions such as thought-provoking (SATIC 3c, e.g. “How is it being transferred?”) and extended-answer (SATIC 4, e.g. “Why are they essential to the food web?”) questions. When Teacher F-4 used these latter types of questions, students provided longer and more elaborate responses. This increased opportunities for engaged student discussion and assessment of students’ current ideas (including misconceptions) about food webs. As mentioned above, Teacher F-4 lectured during direct instruction of the types of consumers. This accounts for marks in making statements (SATIC 2; 2 incidents) and 10 marked incidents of SATIC 1, in which each mark occurred for roughly every 20 seconds of continuous teacher talk.

**Responding:** Teacher F-4’s use of responses was varied in their type and effectiveness (See Figure 12). Student-centered responses such as asking for elaboration (SATIC 11; 7 incidents) and using student ideas (SATIC 12; 1 incident) accounted for less than one third of all responses (31%). Teacher F-4’s SATIC 11 responses asking for elaboration often were the one-word response “Why?” Teacher F-4 neutrally acknowledged student comments (SATIC 6) twice by saying “okay.” The remaining responses (62%) were teacher-centered and included incidents of rejecting (SATIC 8, 3 incidents); confirming or praising (SATIC 7; 2 incidents); repeating (SATIC 8; 4 incidents); clarifying (SATIC 9; 3
incidents); and answering (SATIC 10; 4 incidents) students’ comments. Most of these reactions to student comments could have been reworded into student-centered responses (SATIC 11, 12), a habit promoted by ISU SSTEP to increase engagement and assessment. For example, Teacher F-4 could have asked students how they could find out these ideas or questions they posed with each other about consumer interactions.

![Figure 12: SATIC coding for Teacher F-4 (one observation)](image)

**Non-verbal Behaviors:** Teacher F-4 communicated respect and affirmation to students by using eye contact and listening to their comments. Her facial expressions and body language were mostly subdued, not as easily communicating some of her encouraging and joking comments with students. She moved about the room from group to group during the food web and food chain activities. This motion, however, was not consistent throughout the entire room. She typically rotated among groups in the front two rows of tables, which
afforded some students in the back row to tease each other and not stay engaged in thinking about the concepts modeled by the activity. Teacher F-4 also stood mostly at the front of the classroom during discussion and whole-class segments. To increase engagement and improve classroom management, Teacher F-4 could have stepped away from the front, perhaps joining students at a table or standing to the side or back of the room. As taught in ISU SSTEP, she also could have encouraged student volunteers write their ideas and summaries on the board. Or she could have had each group write their reflections on paper before sharing. Instead, Teacher F-4 did all of the writing on the blackboard, constraining student contribution and creativity.

**Perceived Goals for Students**

In the on-line questionnaire, Teacher F-4 reported she has ten goals for students, five of which have her most emphasis:

a) *Students will display critical thinking skills (#2)*
b) Students will display problem solving skills (#4)
c) *Students will display creativity (#7)*
d) *Students will have a deep understanding of science ideas (#11)*
e) Students will understand the nature of science (#3)
f) *Students will display a positive attitude towards science (#9)*
g) *Students will communicate and defend ideas (#5)*
h) Students will work in cooperative groups (#5)
i) Students will display citizenship qualities (#5, #6)
j) Students will have an awareness of the impacts of science on the world around us (#6, #12)

Teacher F-4 took her medical leave of absence from teaching in the fall semester. After a few weeks into the spring semester when she returned, she gave her students the goals questionnaire (See *Figure 13*). Average response rankings for all goals were between than “moderate emphasis” (3) and “much emphasis” (4). The goal with the lowest average
ranking was Goal #6: Students will actively participate in working towards solutions to local, national, and global problems (mean = 3.20, SD = 1.112). The next two goals with the lowest average ratings were Goal #11: Students will demonstrate deep understanding of science concepts rather than mastery of many insignificant/isolated facts (mean = 3.33, SD = .966) and Goal #12: Students will demonstrate an awareness of the importance of science in many careers (mean = 3.33, SD = 1.072).

Classroom observation, artifact analysis, and the teacher interview provide additional information about the student goals Teacher F-4 promotes. Some discrepancies exist among these data sources and the student questionnaire responses. Most goals were moderately promoted during the classroom observation, with only conveying a positive attitude about science (#9) and demonstrating a deep content understanding (#11) being extensively promoted. Student group work did foster plentiful communication and collaboration (Goal
#5); however, the tone of interactions was often discourteous and not all students’ ideas were treated respectfully by other students. The goal of accessing, retrieving, and using existing scientific knowledge to investigate phenomena (#10) was not promoted during the observed lesson. Critical thinking (#2), creativity (#7), problem solving (#4), and making decisions/self-evaluation (#8) are promoted in some activities (see Artifacts below). Nature of science (NOS) understanding (#3) was not explicitly addressed in the observed lesson, classroom artifacts, or teacher interview.

**Interview**

Teacher F-4 refers to her research-based framework when discussing science teaching. She acknowledges the importance of using this framework. Still, she experiences challenges that hinder this consideration:

I try to keep the general ideas of my RBF in mind whenever I design lessons. However, I admit that this is not always the case. With the constant time-consuming challenges of teaching, it sometimes goes by the wayside. At least once a year, I try to read my RBF and remind myself of what I ideally want my teaching to look like.

I can’t say I always think of [my research-based framework], but I think it’s always in the back of my mind when I try to think of what I want to do as a teacher. Obviously, there’s always room for growth and I always want to improve my teaching. And I’ve tried to go back and consider what I did learn while I made my RBF. And what are my goals for students? And what I’ve learned about how to get my students to where they want to be.

Teacher F-4’s use of her RBF does not always explicitly inform her decisions. Nevertheless, she does use it as a target. Teacher F-4 reports how a sizeable portion of her aim is toward the goals she has for students.

I think [goals] are important because they give me a focus point. What do I really want for my students to come out of my teaching? What are my ultimate goals versus just teaching content knowledge? I think they help me focus on what I want for my students. And they help me determine what teaching methods are going to help me get that for my students.
Teacher F-4’s student goals act as a guide, but she also considers the context of each lesson and class. She discusses the importance of finding the right balance and acting accordingly:

“You always have to respond to your students and their needs at the time. So there may be times when I’d change what I’m doing based on my students’ needs. And I would have to back off more than I wanted to in making it so student-centered until I get them built up to the point where I need them to be. But I think ultimately it still comes back down to the RBF and my goals for the students and how to build them up to the point where I want them to be at [the end of the year].

Despite her reference to goals as a main component of her teaching, Teacher F-4 does not explicitly refer to these goals when asked what considerations she makes when planning and teaching a lesson. Instead, she highlights indefinite ideals for student outcomes and refers to barriers to her practice:

With time limited, I don’t spend as much time as I’d like to on planning good lessons. But ultimately what I try to look at is that my students are mentally involved, so that they’re trying to create meaning from the lesson and it’s not just me giving them information. That’s probably the main thing I focus on.

When asked about characteristics of effective lesson plans and curriculum, Teacher F-4 again alludes to the notion of “mentally engaged” students and deep content understanding.

[I look for] things that are getting students actively, mentally engaged in the lessons. And lessons where we can start really building up in-depth knowledge versus just covering vocabulary. Just getting more in-depth on the material. I think that we decide our important concepts that we want our students to understand.

Teacher F-4 uses the identifier “we” to describe her group of colleagues in the science department. When asked about the curriculum guidance from the department or a district committee, Teacher F-4 answers that not much exists.

We’ve been working on trying to get some curriculum developed. But that keeps falling through. It’s kind of up to us. And there’s one more biology teacher [and] we kind of try to cover the same material. But we both do it in very different ways. We’ve been working on mapping [curriculum], but that’s been going on for years and
we haven’t gotten very far. No, there hasn’t really been a lot of guidance in what we should be teaching. [laughs].

Teacher F-4 expresses her frustration with this lack of guidance. Interestingly, she seeks input from an outside source despite her individually written research-based framework for teaching science.

I can teach whatever material they want covered. But it’d be nice to have guidance on what they want covered versus we’re just floating through and choosing things that we think are the most essential. In some ways it’s nice to have the freedom to do that. But it would also be nice if we could have some consistency in the department.

Teacher F-4 reports their department is still working to achieve such consistency. While such a streamlined approach may increase efficiency and sameness, it may also foster institutional constraint to Teacher F-4’s current teaching practice. This is a possibility she does not identify.

Teacher F-4 does describe a school-wide endeavor to provide uniform curricular and instructional strategies across subject areas. This effort experiences resistance, however.

[T]he whole school has been working more towards student-centeredness. And the students are really struggling with it. And they get a little defiant about it sometimes. And they get frustrated, so there’s definitely a period of frustration until they accept it. [laughs] But it’s just an ongoing process. I don’t know that I’ve ever gotten a class completely where I want them. But they definitely make gains.

Teacher F-4 experiences student resistance to not only district programs, but also to her own classroom behaviors.

My students would probably tell you I ask them too many questions. And they get frustrated with me. But I think it’s something I’m constantly working on. But asking questions that they’re having to consider, think, and reason for themselves versus me giving them information is one of the things I try to do the most. I guess I don’t like lecturing and I don’t like just providing information because I don’t think the students learn very well in that situation. So [I work to create] situations where they’re actively thinking about material and [I am] questioning them to lead them to where I want them.
Teacher F-4’s reasons for these behaviors are somewhat ambiguous and personal. For example, rather than referring to research on how people learn or her goals (both promoted at ISU SSTEP), Teacher F-4 alludes to not liking lecture and not thinking it works well. However, Teacher F-4 does report specific actions she is taking to enhance her interactions and lessons.

I’m always trying to improve. One thing I’ve flipped in and out of it is I ask the yes/no questions and I’m trying to catch myself not doing that and always trying to come up with more higher level questions to ask my students.

[I work on] questioning skills, taping myself or having my principal or colleague give me some feedback. I’m working on doing better lesson plans ahead of time versus trying to do everything at the last minute. [laughs] Those are probably the main things. Trying to come up with a curriculum that we’re happy with. And develop some good lesson plans that can be used off of those.

Teacher F-4’s words indicate purposeful action to monitor and improve her teaching. Her actions include individual and collaborative efforts focused on both instruction and curriculum.

**Artifacts**

As alluded to earlier, artifact analyses of Teacher F-4’s classroom materials and assessments enhance insight into her student goals. Teacher F-4’s chemistry class assignments feature several investigative activities. For example, early in the year, students complete an open-inquiry lab that requires them to develop a procedure that will help them identify components of an unknown powder. Another chemistry activity asks students to design and carry out an investigation determining which of two blocks having similar size contain the most mass. This latter activity, though, has the title “Sink or Swim” at the top of the handout, which may clue students as to what methods they could use. Assessments
contain short answer and essay questions, fostering creativity and critical thinking. However, some of these questions ask for one-word answers such as terms or classifications.

Teacher F-4’s biology artifacts include an assessment on science processes such as hypothesis, qualitative and quantitative observations, and variables. No explicit attention is given to NOS concepts such as creativity, tentativeness versus durability, historical and human connections with science. Half of the questions on this biology assessment are multiple choice questions, which limit students’ critical thinking, communication skills, creativity, and deep content understanding. Of the remaining questions on this particular test, a majority requires one-word responses or lists of two or three items. One biology assignment is a “Climate Webquest” handout that requires students to answer definitions and listing questions based on information provided by a given website. Not all assignments are as traditional and pedantic, however. Teacher F-4 gives her biology students a creative writing assignment in which students work in pairs to write and illustrate short stories about the journey of a molecule through an ecological cycle. Another assignment requires students to work in groups to research and present information on their chosen biome. Students are given general evaluation criteria such as accuracy/completeness, communication skills and working in groups. Teacher F-4 does not tell students, however, how students should go about with this completing this project such as which resources to use, what information is valid, and what methods to use in the presentation. Such projects foster many student goals such as creativity, communication, problem solving, deep understanding, setting goals and self-evaluating. Despite doing these alternative and performance-based projects, students still must complete traditional written tests such as the one described above.
Summary

Habits of Understanding: Teacher F-4 conveys an understanding of research-based reasons for her choices in lessons and classroom behaviors. This is evidenced by her interview responses alluding to meeting students’ needs, promoting goals, and methods to do so. This rationale, however, is sometimes disconnected from her lesson decisions. For example, she mentions ambiguous criteria for “mentally involved” students as the ultimate consideration for planning lessons. She also relies on an outside source (district, department, etc.) for choosing curriculum as opposed to using her understanding to inform these decisions. These behaviors exhibit a moderate match (M) to habits of understanding promoted by ISU SSTEP.

Habits of Action: Teacher F-4’s habits of action are a moderate match (M) to ISU SSTEP. Lessons and activities, evidenced by data in classroom observation and artifact analysis, show a concerted effort to promote goals for students such as critical thinking, creativity, communication and collaboration. Many assessments and assignments, however, focus primarily on surface memorization as opposed to deep content understanding and application. Teacher F-4’s teacher behaviors show partial alignment with ISU SSTEP. For example, she uses some open-ended questions (SATIC 3c, 4) and student-centered responses (SATIC 11, 12), the interaction pattern promoted by ISU SSTEP. However, these occur roughly half as frequently as simple questions (SATIC 3a, 3b) and teacher-centered responses (SATIC 5, 7-10).

Habits of Reflection: Teacher F-4 exhibits habits of reflection that have a moderately high match (MH) to ISU SSTEP. Teacher F-4’s yearly review of her RBF paper indicates a habit of reflecting on her framework for decisions regarding curriculum and
instruction. She also identifies her emphasis on using questions that encourage critical thinking as opposed to memorization of facts. Although she uses general terms, Teacher F-4 shows she is conscious of both her current and her desired state. At the same time, Teacher F-4 also mentions her reliance on outside forces for curriculum decisions, as opposed to taking a leadership role in choosing appropriate content based on her goals and understanding of learners.

**Habits of Improving Practice:** Teacher F-4 has an extensive action plan for improving her instruction. As she indicates in her interview comments, Teacher F-4 uses audiotapes and colleagues to help her monitor and practice her questioning. She also actively tries to reword her questions during lessons, although reliance on effort in the context of teaching would not be fruitful without her other actions for monitoring and practicing. Teacher F-4 seems to indicate reliance on external forces to improve her curricular decisions. For example, she seeks a department-issued uniform sequence of instruction. ISU SSTEP promoted the practice of teachers having and using a research-based framework to make such decisions. All of these behaviors exhibit a moderately high (MH) match to the habits of improving practice taught by ISU SSTEP.

**Overall Alignment of Habits with ISU SSTEP:** Teacher F-4 articulates specific habits she uses in reflecting and improving her teaching. Her understanding and actions are less consistent with ISU SSTEP. These habits, though, relied on one observation and conclusions about student goals without data from a student questionnaire. Analysis of Teacher F-4’s overall alignment with ISU SSTEP can only rely on the available evidence. Triangulation of data from observation, artifacts and interviews increases validity of these
conclusions. The above summaries result in an overall moderately high (MH) match between Teacher F-4’s habits and those of ISU SSTEP.

**Teacher F-5: 2nd Year Teacher (Former Program)**

**Overview**

Teacher F-5 is actually in his first full year of teaching. Last year, he began at his position starting at winter break and taught one semester. He teaches the same class subject (9th Grade General Science) at the same school as Teacher C-5. This building is a unique freshman-only building in a thriving suburb of middle and upper-middle class residents. Teacher F-5’s students are approximately 80% white and 20% minority. Despite the nearly identical situations between Teacher C-5 and Teacher F-5, their classrooms are nearly complete opposites in view of student behavior, teacher behavior, and learning. In the classrooms observed, Teacher F-5 had significant classroom management problems. The students practically “walked all over” him, in that they displayed little or no respect to Teacher F-5, did not listen to his instructions or questions, and were off-task for most of the class period. Not every student exhibited these overt behaviors, but it took only a few to actively antagonize and push the limits, thus disrupting the entire classroom. Since students experienced no consequence for their actions, they pushed even more, followed by even more students. Little or no learning occurred in this class, yet such ineffectiveness was not due only to an inability to manage or discipline students. Teacher F-5’s lack of effective teaching strategies and behaviors also contributed to this ineffectiveness. As taught in ISU SSTEP, effective teaching of science through inquiry, engaged discussion, and application also leads to effective classroom management. Teacher F-5’s teaching lacked both.
Content, Activities, COP Coding

Lessons observed in Teacher F-5’s classroom were simplified to the game of schooling. Teacher F-5 used some demonstrations with students such as spring wave models, but most were limited to gimmicks and did not deeply explore the fundamental concepts. No explicit attention was given to drawing out or identifying potential misconceptions created by these examples. Little or no application occurred between concepts and real life situations. Students were required to do little thinking or learning, doing actions such as passively sitting and listening to the teacher; filling out worksheets; following an on-line tutorial; watching a video; and following step-by-step instructions on a lab using microscopes, stains and potato cells. These activities, as well as the content units, were piecemeal and disconnected. In the lessons on waves, the emphasized objective was for students to identify longitudinal and transverse waves. Defining terms was the only focus, with little speculation or examination as to comparing and contrasting these two types of waves.

The video used in one observation had limited impact with its presentation of wave phenomena, as students could have easily tested and experienced most of the concepts in real life demonstrations or explorations. The video presented multiple terms with little or no elaboration, even posing some analogies that might have increased students’ misconceptions. Examples are a racecar analogy that obfuscated the relationship between waves and energy; diagrams that depict electricity, magnetism, and electromagnetic current in nearly identical ways that students could easily misconstrue. This media could have been salvageable if Teacher F-5 had posed questions to the students to engage their thinking as they watched. For example, when the video narrator stated that sound’s speed changes in different
temperatures and media, Teacher F-5 could have paused the video and asked, “Why might this be?” or “How does sound’s speed change when in these new conditions?” Instead, he let the video play and did not take any action to engage the students. Teacher F-5 gave no prompting questions to the students before or during the video, so students had nothing to think about as they watched. During the video, the classroom was dark with blinded windows and all lights shut off. Students could not see to take notes; many used the shadowed classroom as an opportunity to daydream or whisper to neighbors. The video was an example of the pedantic instruction in Teacher F-5’s classroom. As seen in Figure 14, the COP ratings of these observed lessons were all relatively moderate to low. Students were not

![Figure 14: COP coding for Teacher F-5](image)

*Maximum Capsule rating is 8; all other categories have a maximum rating of 5
engaged in discussing and investigating ideas, the classroom was not well paced or managed, science was presented as static and memorization, and students experienced negligible intellectual rigor.

**Teacher Behaviors and SATIC Pattern**

Teacher F-5’s teacher behaviors were extremely teacher-centered, yet this did not demand any respect or attention from the students. The only indication for checking for understanding during one observed lesson was asking students to “raise your hand if you don’t understand.” As taught in ISU SSTEP, such an interaction yields little indication of student understanding, as most students would not be quick to admit confusion and some may assume understanding but may actually hold misconceptions. A breakdown of Teacher F-5’s classroom behaviors follows and is coded in Figure 15.

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**Figure 15: SATIC coding for Teacher F-5**
**Questioning:** During three observations, Teacher F-5 asked only two open-ended questions, both thought-provoking (SATC 3c). No extended-answer (SATC 4) questions were asked in three observations. These two types of questions (SATC 3c, 4), the kind promoted in ISU SSTEP, account for less than 3% of Teacher F-5’s entire initiatory behaviors. Simple yes/no/dichotomous (SATC 3a; 20 incidents) and short-answer (SATC 3b; 20 incidents) made up 57% of Teacher F-5’s initiatory behaviors. The remaining 40% of initiatory behaviors in the observed lessons were either lecturing/giving directions (SATC 1; 17 incidents) or making statements/asking rhetorical questions (SATC 2; 11 incidents). As addressed earlier, Teacher F-5’s lessons emphasized surface memorization and recall of terms, with limited exploration of concepts and students’ ideas.

**Responding:** Consistent the above questioning pattern, Teacher F-5’s responses were typically teacher-centered with few interactions encouraging deeper discussion or examination of students’ ideas. In three observations, Teacher F-5 had only three student-centered responses, all of which were asking students to clarify or elaborate (SATC 11) and all occurring in the first lesson that reviewed wave concepts. No incidents occurred of using student questions or ideas (SATC 12) in the three observations. In all, student-centered responses (SATC 11 and 12) accounted for 7% of Teacher F-5’s responses. Value-neutral acknowledgement of student comments (SATC 6) occurred six times in the three observations (14% of all responses). Teacher F-5 would say “all right” after a student comment, which could easily have become an annoying mannerism if used slightly more often. The majority of Teacher F-5’s responding was teacher-centered. Of these, the most frequent response was answering student questions (SATC 10; 17 incidents), accounting for 40% of all of Teacher F-5’s responses. Other teacher-centered responses consisted of
rejecting (SATIC 5; 5 incidents), confirming (SATIC 7; 2 incidents), repeating (SATIC 8; 5 incidents), and interpreting (SATIC 9; 4 incidents). Numerous opportunities to assess and engage students’ thinking were short-circuited. Rather than asking students to elaborate on their ideas or explain how they came up with answers, Teacher F-5 would tell them the answer or if they were right or wrong. For example, in one exchange, Teacher F-5 asked the class to identify a wave. A student responded, “transverse.” As taught in ISU SSTEP, Teacher F-5 could have asked, “How do you know?” to encourage further thinking. Instead, Teacher F-5 responding by saying, “Transverse, okay.” This instance was typical of Teacher F-5’s interactions with his students, which emphasized answering the teacher’s questions about terms and little analysis or reasoning.

Non-verbal Behaviors: During the three observations, no incidents of inappropriate wait-time I and II (SATIC 13a and 13b) occurred in Teacher F-5’s interactions. Teacher F-5 did give students time after his questions and their comments, but he did not show confidence in his interactions with the class or his understanding of how to investigate the science content. Hence, interactions focused on vocabulary rather than concepts. Despite facing a bombardment of questions and answers about terms with limited understanding, students continued to talk off-task during the entire lesson. This resulted in an annoying mannerism displayed in the third observed lesson. Teacher F-5 would tell students in a disrespectful, stern, yet pleading voice, to “Listen!” Teacher F-5’s voice tone was high and strained, trying to out-talk or talk above the students’ voices. This exasperation and frustration was continually conveyed through his tense, unsmiling facial expressions and taut neck muscles. Eye contact was limited to calling on students’ specific names in an attempt to correct off-task behavior, a method with no enduring success. At other times, though, Teacher F-5
would display no attention or concern for the students. This includes beginning the class, during which Teacher F-5 would take as long as five minutes after the bell before starting class. In this time span, as students got louder and more engaged in their own off-task discussions, Teacher F-5 would be standing at the front of the room sorting materials or taking attendance. The last five minutes of class were also wasted as students packed up their materials and Teacher F-5 let them chat about off-task topics or even line up at the door before leaving. During classroom presentations, lectures, or discussions, Teacher F-5 remained within a five-foot radius at the front of the room between the lecture table and his teacher desk. This lack of proximity among the students was another barrier to effective classroom management, engaged thinking, and assessment of student learning.

**Perceived Goals for Students**

In his on-line questionnaire, Teacher F-5 listed only two goals for students. Teacher F-5 did not indicate relative emphasis for either goal:

\[\text{a) Students will be individual thinkers (#1)}\]
\[\text{b) Students will develop critical thinking skills (#2)}\]

Teacher F-5 gave goal questionnaires to 72 of his students. Average response rankings for all goals were higher than “much emphasis” (4). The goals with the two lowest average rankings were Goal #6: Students will actively participate in working towards solutions to local, national, and global problems (mean = 4.18, SD = .845) and Goal #8: Students will set goals, make decisions and self-evaluate (mean = 4.24, SD = .778). This lower relative emphasis is consistent with observations and artifact analysis.
Classroom observations did not detect consistent, extensive promotion of any goals listed. Critical thinking (#2) was moderately promoted usually through questions on assignments. The same was true for Goal #10: accessing and using resources, promoted by on-line or book assignments. Using communication and working cooperatively (#5) was emphasized through group assignments, although little attention was given to engaged discussion of ideas. Rather, student exchanges focused more often on working with a partner and divvying out responsibilities and confirming procedures. All other goals—self-confidence (#1), NOS (#3), problem solving (#4), working toward solutions to local/national/global problems (#6), creativity and curiosity (#7), goal-setting (#8), a positive attitude about science (#9), deep understanding of fundamental concepts (#11) and science in careers (#12)—were essentially never promoted in the observed classroom lessons. The analysis of artifacts (see below) supports the observation conclusions of goal promotion.
being limited to surface content knowledge. Communication, critical thinking, positive attitude, and more all have minimal promotion in Teacher F-5’s curriculum materials and classroom instruction.

**Interview**

Teacher F-5 cites his student goal as a helpful guide in his teaching. He refers back to his experience in the ISU SSTEP science methods class (one semester, former program) as being important for his teaching:

The things I got out of [the class] was through the RBF [paper], having goals for my students. That’s probably helped me more than anything as far as staying focused on what I want to do every day.

When asked about the importance of his goals, Teacher F-5 explains in broad terms with no specificity about the characteristics and skills he wants his students to learn. Instead, he focuses on the goals’ value in students’ future schooling and working:

Those are things that [students] will need after school. They’ll need when they get out of school. They’ll need when they go to [high school]. They’ll need when they go to college. They’ll need if they get a part-time job or if they go right to the workforce when they get out of high school. Those are things that they are going to need. Those are things that will help them succeed in life.

Rather than citing immediate value to students’ lives, Teacher F-5 pushes the importance of goals onto delayed benefits. This is contrary to the habits of understanding and action promoted in ISU SSTEP, which teaches the direct and positive impact such goals have on students’ everyday lives for the present as well as future.

In contrast to Teacher F-5’s ambiguous and generalized responses about goals, his recollections about learning from coursework at ISU are highly specific and narrow. For example, when asked about the limited value he reported about his general education
coursework experiences, Teacher F-5 shares his desire to learn about precise research on student grade levels as opposed to common themes applicable to larger age ranges.

I thought Educational Psychology was too broad. . . . I was going to go into high school teaching. If there was an Ed Psych course that talked about specifically high school kids—why they think what they do. Because once you find out why they’re thinking the way they do, it’s easier to manage them. So I think if it was not such a broad age range and you could specifically get into one age group, it would be more beneficial.

Teacher F-5’s previous comments indicate he has a limited understanding about research on how people learn. While differences exist among learners depending on developmental maturity, research on learning provides ample evidence on the similarities of all learners regardless of age level. Rather than learning about learners and applying these concepts to his specific situation, Teacher F-5 prefers specific knowledge he can directly apply to his classroom. As the ISU SSTEP science methods class taught, teachers who rely on simple tricks without a deeper understanding become mere technicians and not educators.

Nevertheless, Teacher F-5 still prefers picking up these tricks as opposed to learning concepts and developing a sufficient research-based framework. Consider his comments about a Senior Seminar class (one hour per week) he reports as particularly valuable to his teacher preparation:

I found that [class] helpful because we had a chance to talk to other teachers. Teachers come in and tell us what they did. Actually, I got a lot of ideas from that as far as different ways to group students together and have them brainstorm ideas and then take it to the whole group. We did a lot of stuff like that. I found that fairly helpful, if we’re talking about the same one.

Learning particular strategies does benefit teachers like Teacher F-5. Unfortunately, teachers who learn these activities without a solid understanding of the underlying concepts are ill-
equipped for decision-making in the dynamic classroom. The observations of Teacher F-5’s classroom teaching are evidence of the resulting frustration and futility.

Teacher F-5 does allude to some considerations of research on how people learn when describing his process of planning and teaching lessons. These references are brief and at a surface level, however, and Teacher F-5 focuses mostly on specific classroom encounters. He shares the following anecdotal experiences in his answer to what factors go into consideration for planning and teaching a lesson:

Well, right now we’re doing electricity. So I tried to figure out what the students already knew and we did some of that, they knew what charges were, some of them knew what an ion was. Getting into their misconceptions. It’s actually electricity and magnetism. Some of them are confused on what is the basic difference between electricity and magnetism because they would look at the north and south pole on a magnet and the plus and minus on a battery and they would kind of equate the two.

So it’s just kind of getting at their misconceptions right now and taking those apart and trying to reprogram them so that they have a better understanding of it. I’ve gotten better at that. Right now, I just ask students, “What’d you do in 8th grade? What do you remember from that?” It’s funny because they’ll say, “Well, we’ve had this stuff,” or the last five years, “Why are we learning this again? Every year we’ve had this.”

Maybe that’s just the way the curriculum is set up here in [this school district]. When you probe a little deeper, they’ve had it, they’ve heard the words, they don’t really know what they mean, they can’t really apply it. And I’ve been trying to have them actually apply this stuff that they’ve learned. The content that they’ve learned. Have them apply it to something, hoping they’ll understand it better when we get done with it. We’ll find out. [laughs]

Teacher F-5 does recognize important features of effective teaching, as promoted by ISU SSTEP. He acknowledges the role of students’ prior knowledge and misconceptions. His means of drawing out and dealing with these ideas, however, are not consistent with ISU SSTEP. Teacher F-5’s strategy for finding out students’ understanding is asking them what about their previous year of science. The extent to which he can accurately assess
preconceptions is limited, as students may not be able to articulate their depth of understandings beyond “We’ve seen this before.” Teacher F-5’s strategies for teaching include application as a means for conceptual change. His understanding, though, about the research supporting these practices is limited mostly to “hoping” it will work.

Teacher F-5’s reflections and understandings hinge on his anecdotal experiences, rather than underlying research-based concepts and skills. As a result, he struggles to identify and articulate the extensive role of his questions, responses, and non-verbal behaviors with students. When asked about his interactions, Teacher F-5 again refers to his current unit. His attention first goes to finding an activity to “make students think.”

Right now, this unit, I think this is going pretty good. Some units are easier. When we were talking about human growth and reproduction, I think it’s a lot harder to do things in the lab or do things in the class that make students think a little more. Electricity seems to make them think a little more.

And I fall back on the wait-time and things like that that [the ISU SSTEP professor] stressed as being really important to getting students to talk. And they’ve learned at this point I don’t usually answer their questions. Which sometimes, maybe they won’t ask them. That could be a drawback. “He’s not going to answer our question, so why should we ask it?” They still ask questions some. I usually try to get them to answer. Because a lot of times, they have an answer or they have an idea of what the answer it is, they just don’t have the confidence. And a lot of times it’s just getting them to think more in detail about what they are thinking of. Kind of formulate it in their mind and come up with an answer.

As he reflects, Teacher F-5 does recognize the role of students’ questions and wait-time. These components, however, are mentioned mostly in the context of doing what he was told to do rather than because of a research-informed decision. This is further evidenced by the discrepancy between Teacher F-5’s claim of trying to get students to the answer and the observed classroom tendency to go ahead and answer students’ questions 40% of the time (See Teacher Behaviors and SATIC Pattern). Nevertheless, Teacher F-5 does include
insightful comments about how his refusal to answer student questions may discourage their participation.

It’s funny because they’re so programmed with [thinking], “You’re the teacher. You should have the answers.” Where that comes from, I don’t know. It comes from their last eight years of schooling. But that’s one of the tough things to overcome. They want answers. “Just give me the answer. That’s all I want.”

They’re used to that. You see that in other teachers. Students just want answers. There are other teachers who have expressed that. They see it in their classes.

Teacher F-5 knows that students’ ideas are important. Moreover, he identifies the link of student resistance to their previous and current schooling experiences, a form of institutional constraint. However, Teacher F-5 never speaks to how he would address the challenges of fostering increased participation. He makes no connections among his own questions, wait-time, non-verbal behaviors, classroom management—all of which ISU SSTEP teaches are essential for productive classroom interactions.

When asked about how he would change his classroom interaction patterns, Teacher F-5 is quick to identify his problems with classroom management. His solution, though, is broad and lacks any specific steps toward execution of this plan.

How would I change? First of all I would be a lot stricter. I’ve tried doing that second semester. Everyone comes in the new semester, [I say], “All right, we’ve got a new semester. I’m cracking down, new attitude. These are things that I let off last semester. My mistake, I shouldn’t have done it. I’m going to be a little stricter.” And I think it’s working a little better. Next fall when I start out, it’ll be high expectations. I don’t think this fall I had high enough expectations or I didn’t voice those expectations to the students. Which I think my expectations for them need to be elevated and they need to know that.

Teacher F-5’s reflection lacks articulation toward reasons for his current state and actual, measurable means to get to his desired state. His plan of action is to be stricter and have high expectations. Yet he never describes how he will do this.
The only other item Teacher F-5 mentions with respect to changing his classroom interactions is finding better activities. He reflects on his immediate classroom experiences, sharing a story and never relying on a research-based framework:

Then another thing I was thinking about today: we’re doing battery-bulb-wire. I was really surprised; a lot of [students said], “We’ve already done this.” Coming up with things that they’ve never done before is very challenging. [They say] “We did this last year. My sister did this in 5th grade or 3rd grade or something and I helped her with it.” So coming up with either different activities for them to do or taking the ones that they’ve done already and not really putting a different twist on it, but presenting it in a more challenging way. So that they have to put more thought into what they’re doing. That’s a tough one. That just struck me today, that is really a big challenge. A lot of [students said], “We’ve done this already. I already know what to do.” And they don’t. I’ll find out tomorrow whether or not, because I had them draw pictures of a battery, a bulb, a wire, how are you going to light it. And some of them today drew pictures. And the pictures look like they’ll work. But when they actually get in the lab and try to do it, we’ll see what happens.

While activities are important for effective teaching, they alone do not address or improve a teacher’s classroom behaviors. When probed further about areas for improvement, Teacher F-5 remains fixed on the indefinite “high expectations” and idealized “new activities.”

Those are probably my two main areas that I want to improve on. I want to create the atmosphere that there are high expectations. I want students to know that there are high expectations on them. And I think some of that’s going to come with me finding things that they haven’t done. New activities, new labs, or changing the ones that they’ve already done. And I’ll know that next year, oh they’ve done this already. So how am I going to present it in a different way so that it makes them think about the knowledge that they already have and take that and apply it to something else?

Interestingly, Teacher F-5 links his classroom management expectations as relying on using better activities. His own interactions and behaviors remain unattended.

Teacher F-5 does report taking some action for improvement based on his previous statements about finding activities. Unlike the ISU SSTEP, which promotes proactive examination of his teaching behaviors, self-reflection, and filtering ideas through a research-
based framework, Teacher F-5 instead seeks the expertise of external sources and time. Self-reflection and self-reliance are minimal.

I mostly throw ideas at [Teacher C-5]. He’s got a little more experience with his student teaching. He’s got a little more experience as far as theoretical things that . . . you can try and apply it to the classroom. And I think just going through a lot of this stuff, when I teach it again next year, most of the students have come up through [this school district’s] schools. They’ve probably done this already or they have some kind of knowledge. So I can then expand upon that in some way. How I’m going to do that I’ve got no idea yet. I mean, reading and looking at the NSTA website. Get ideas from other teachers. There are so many other teachers in the building that have good ideas; they just have those cookbook labs that are all laid out. You can take those and alter them too. Lots to do and not that much time to do it in.

Teacher F-5’s progression of improvement actions begin with outside sources such as colleagues, hope that experience will enhance understanding, and excavation of activities from digital and peer sources. Teacher F-5’s unique situation of having a fellow ISU SSTEP graduate as a colleague does afford some benefits to his teaching. Teacher F-5 relates this interaction through anecdotal experience, rather than a framework of their joint ISU SSTEP preparation.

For this unit on electricity and magnetism, [Teacher C-5] and I got together and just started, maybe a week before we started, [asked ourselves], “What are we going to do?” So we’re working pretty much every day. We’re kind of doing the same thing so we can compare, “How did this work in your class?” We’ll get together before school and [share], “What are you going to do today?”

So it’s really nice having someone else who is teaching in a similar way because we can throw ideas at each other. And we may start out on Monday morning not really knowing what we’re going to do. And after a half an hour or so, we come up with some kind of plan for where we’re going to go. That’s really been helpful. It’s not easy to do on your own because I tried it last year when I was the only one here teaching like this. You go back to the textbook really fast. It’s not easy to do. It’s very helpful.

Teacher C-5’s own habits of understanding, action, and more act as a sort lifeline for Teacher F-5’s own teaching. Interestingly, Teacher C-5 (from the current ISU SSTEP program) is
looked upon as the one with greater expertise, even though he has less professional experience than Teacher F-5 (a former program graduate).

**Artifacts**

Teacher F-5’s curriculum and instruction artifacts support conclusions made from classroom observations. Assignments and assessments focus primarily on content knowledge, with limited practical application, exploration, or analysis. Lesson plans are skeletal and procedural. The teacher’s role is unclear and lacks questions, examples, or challenges to pose for engaging and assessing student thinking. Technology is present in the form of website resources. These exercises are not investigative, but rather trivia searches. Students receive a worksheet that has a given website at the top and a handful of questions. For example, one worksheet provides a PBS website about blood. Students are told to click on a certain link at this website and use headings picked by the teacher. Questions then ask for finding and repeating information from the website. Some do ask supplemental questions garnering further thought from students, although most inquire about opinions: “Name three pioneers who changed the field of hematology and explain their contributions. Which one of them do you feel is more important and why?” “List and describe three early practices used by different cultures to treat blood-related illnesses. Would these practices be accepted by today’s standards? Why or why not?”

Activities typically have a “cookbook” format and require students to follow directions without critical thinking. Students may develop misconceptions about science and the nature of science (NOS) by experiencing such activities. For example, under the heading “Hypothesis” in a paper tower-building activity, students are asked to “Explain briefly the process for building your tower.” This question may foster inaccurate notions of the
scientific process. Another activity requires students to choose a topic about their school they want to examine, form a hypothesis about the topic, and then design a research project to address their hypothesis. The handout for this activity calls it “the culmination of the nature of science unit.” This activity, however, merely focuses on identifying dependent/independent variables; creating graphs and data tables (based on rubrics outlining the point distribution such as 4 points for correctly labeled axes, 2 points for title, 4 points for legibility and neatness); and answering questions given by the teacher: “What problems did you encounter?” “How did you overcome those problems? If you had no problems, why did your project go so smoothly?” “Identify the independent and dependent variables.” These questions indicate how the project focuses not on NOS, but rather on the organization and communication of an experiment. Teacher F-5’s paper assessments promote term memorization and recall. Questions in these assessments are matching of terms and definitions as well as short answer recall of content: “Describe the atmosphere of Earth as it was 4.4 billion years ago and how it has changed to its present state. (10 points)” “Why is the water cycle important to life on this planet? (10 points)” “You are in a rocket blasting off into outer space from Earth. List the five layers of the atmosphere as you ascend (go up) and describe the changes that you would experience as you traveled through the first two layers of the atmosphere. (10 points)”

Summary

Habits of Understanding: Teacher F-5 does have an awareness of student goals’ role in his teaching. However, Teacher F-5’s own descriptions indicate a surface knowledge of goals. Teacher F-5’s reliance on specific activities and external direction is incongruent with the teachings of ISU SSTEP. He displays shallow comprehensions and applications of
concepts like student goals, students’ ability to handle abstractions and prior knowledge, and his subsequent behaviors in the classroom. As a result, it is concluded that Teacher F-5 has a low match (L) to ISU SSTEP with respect to habits of understanding.

**Habits of Action:** Teacher F-5 has a low match (L) with the habits of action promoted and modeled through ISU SSTEP. Goal promotion was limited to content knowledge, and even this is hindered by traditional teacher-dominated instruction and curriculum. Students were typically disengaged in learning doing off-task behaviors. When on-task interactions did occur, the learning focused on content recall and memorization.

**Habits of Reflection:** When speaking to his teaching, Teacher F-5 typically uses anecdotal descriptions. While teaching is considerably context specific, it also relies on underlying concepts and skills. ISU SSTEP promoted such foundations like research on how people learn, student goals and actions, selection of content and materials, and teacher behaviors and strategies. Teacher F-5 rarely refers to these essential pieces of a research-based framework. Instead, his focus is on a past or present lesson, unit, or exchange with students. These anecdotes could be helpful with reference to how they support or epitomize fundamental understandings. However, Teacher F-5’s allusion such bases are infrequent, indistinct, and—at times—inaccurate. Therefore, his habits of reflection have a low match (L) to those of the ISU SSTEP.

**Habits of Improving Practice:** Teacher F-5 limits his actions for improvement to two main objectives: increasing expectations and finding better activities. Teacher F-5’s plan for meeting the former is by being stricter. He gives no attention to his classroom behaviors and how he could practice and monitor them, all of which are key pieces to the ISU SSTEP. Teacher F-5’s hopes for finding better activities are limited mostly to collecting
from colleagues or digital catalogs. He does take advantage of having another ISU SSTEP graduate (Teacher C-5 from the current program) in the same building, as they share ideas for planning and teaching. However, this collaboration appears to mostly consist of finding quick fixes for Teacher F-5’s classroom needs. Like his ambiguous actions for higher expectations and better activities, Teacher F-5’s preference for stopgaps indicates a low match (L) to the habits of improving practice taught through ISU SSTEP.

**Overall Alignment of Habits with ISU SSTEP:** Like Teacher C-5 in the same school building, Teacher F-5 expresses awareness of institutional constraint and pressures to follow a more traditional curriculum. He mentions his struggles with writing lessons that are relevant to what the students need to know, rather than following the textbook sequence. Science concepts addressed are often disconnected and not integrated. Nevertheless, Teacher F-5 does little to transform these restraints and barriers to what he indicates he knows about a research-based framework for teaching. Although Teacher F-5 states he knows it is important to expose students’ misconceptions and attempt to correct them, his classroom teaching reveals little attention to drawing out students’ ideas and successfully helping students make connections to correct concepts. Instead, he reverts to traditional teaching—lecturing, pedantic question-and-answering, filling out worksheets, hunting for trivia on websites—with uninspired and ineffective results. For these reasons and those given above for each habit, Teacher F-5 has a low match (L) to the overall habits promoted by ISU SSTEP.
**Teacher C-1: 3rd Year Teacher (Current Program, MAT)**

**Overview**

Teacher C-1 is a 3rd year teacher of 10th Grade Biology at a large suburban high school, located in a middle and upper-middle class community. Teacher C-1’s classroom teaching indicated a solid foundation and fine-tuned practice, albeit with a few poor tendencies. He had a relaxed demeanor and a pleasant relationship with his students. They were quiet and mostly attentive during the class. Usually, students were physically involved in lessons, requiring them to be mentally engaged in learning or, at the very least, paying attention and following along with their peers. No significant management issues occurred, though some students may not always have been mentally engaged, able to quietly sit in their desks or allow other group members to lead. The class had a tone of comfort and humor, although the students displayed maturity and responsibility for their behavior in class, something that was expected and welcomed. Posted on walls and positioned on shelves and cabinets were various student projects and posters indicated explicit study into the historical and social natures of science. Creativity abounded in these displays communicating the history of investigating DNA and other topics, even tenets of the nature of science (NOS).

**Content, Activities, COP Coding**

Students were closely involved in decision-making with the biology lessons in Teacher C-1’s class. In the first observation, students worked in small groups to examine various stages of cell meiosis. They drew diagrams and descriptions on the class chalkboard and then reviewed as a class how the various stages compared. In the second classroom observation, students worked in small groups at various stations on the laboratory
countertops. As a class, they performed an activity modeling natural selection of birds, beaks, and feeding. In groups of three, each student used different tools (tweezers, spoons, chopsticks) to retrieve various types of seeds (sunflower, etc.) during 30-second time allotments. They then used a provided data table to record the amount of seeds acquired and used a given formula to determine the number of “birds” in generations after each feeding. This portion of the lesson reflected an exploration stage of the learning cycle, using a hands-on experience with familiar materials to be the foundation upon students would learn abstract biological concepts. Students were engaged in this “fun” activity and kept their own records of data, observations, and answered questions given on a handout connecting their experiences to natural selection of birds and interactions with nature. Implementation of this second lesson was lower than other COP categories (See Figure 17) due to the lack of time for private reflection or public discussion of ideas. Even though this lesson was primarily exploration, the teacher did not ask open-ended questions or encouraging discussion to engage the students in thinking about their ideas during the experience. On the third observation (the next day), the class reviewed their natural selection activity, did a small group “jigsaw” task of researching and sharing various influences and categories of natural selection, and then did a whole-class review of the concepts. Teacher C-1 presented information through lecture and making statements and did not encourage students to share their thoughts and discuss with peers about the concepts. This final part was the weakest of any lesson observed of Teacher C-1, hence the lower ratings in the COP for this third observation. Teacher C-1 attempted to address this catalog of concepts in a short amount of time. He was fully aware of this influx of information and its potential limit of worthwhile learning on the students. After the class lesson, Teacher C-1 spoke of the lack of time
available to the concepts, due to an upcoming end of the semester and preparation for break and final exams. Across the three observations, Teacher C-1’s implementation score is lower than the other categories. One reason is due to short-circuited opportunities to ask more open-ended questions, use student-centered responses and appropriate wait-time II, items discussed next.

![Figure 17: COP coding for Teacher C-1](image)

*Maximum Capsule rating is 8; all other categories have a maximum rating of 5*

**Teacher Behaviors and SATIC Pattern**

Even though students had an active role, Teacher C-1 did not leave them alone. Teacher C-1 interacted with students in the classroom, always actively engaging and guiding their thinking. As opposed to permitting “discovery” learning without any support, Teacher C-1’s controlled lesson direction through his questions and interactions with students.
**Questioning:** Teacher C-1’s questioning pattern includes a range of initiatory questions (typically SATIC 3a, 3b, and 3c). Out of 44 total initiatory questions, 14 (32%) were thought-provoking short answer questions (SATIC 3c). In just the first observation, SATIC 3c questions constituted two thirds (67%) of the initiatory questions. This lesson featured a discussion of the meiosis stages that students diagrammed on the board. Teacher C-1 asked students questions comparing and relating the various stages of meiosis and mitosis. Teacher C-1 used simpler questions (SATIC 3a, 3b) more frequently in his other observed lessons. For example, 10 of 11 (91%) initiatory questions in lesson two were dichotomous or short-answer. This lesson featured the period-long exploration activity with beaks models and seeds. Most interactions were limited to procedures and compiling data. Still, as Teacher C-1 led the activity by monitoring time allotments, he could have inserted thought-provoking questions to engage students in thinking about their ideas during their exploration. In the third observed lesson, 13 out of 18 (72%) initiatory questions were dichotomous or short-answer. This was the consolidation of the bird/beak activity, and Teacher C-1—due to time concerns—admits to putting more emphasis on “getting through” the content rather than drawing out students’ ideas and encouraging discussion. In doing so, however, he lost opportunities to assess and engage students in thinking by rephrasing simpler questions (SATIC 3a, 3b) into thought-provoking and extended answer questions (SATIC 3c, 4). For example, instead of just giving or asking for concept definitions, he could have asked students, “What do you suppose we mean by biological fitness?” Also, when introducing the concept of the Hardy-Weinberg Principle, Teacher C-1 could have asked students to discuss with a partner they think the phrase “genetic equilibrium” means before telling students to look up the book definition. Promotion of proactive thinking and
discussion reflects research on how people learn and the goals for students, as taught in ISU SSTEP.

Teacher C-1 also used 13 statements/rhetorical questions (SATIC 2) over the three observations. The use of rhetorical questions usually arose from ending statements with “okay?” or “all right?” As addressed below, Teacher C-1 also used these two words separately without statements, coded as annoying mannerisms (SATIC 15).

![Figure 18: SATIC coding for Teacher C-1](image)

**Responding:** As seen in Figure 18, Teacher C-1’s responses are primarily teacher-centered (SATIC 5, 7-10). Out of the 44 teacher-centered responses recorded in three observations, 15 (34%) were repeating student comments (SATIC 8) and 19 (43%) were clarifying/interpreting what the student said (SATIC 9). The former limits student-student interaction as students are taught to listen to the teacher instead of each other. The latter
limits assessment and students’ input; the teacher “puts words in students’ mouths” without asking for elaboration. Teacher C-1’s third most common response (9 incidents) was student-centered SATIC 11, asking students to clarify or elaborate. The type of Teacher C-1’s responses frequently hung in a delicate balance. In other words, with a few simple changes in word choice, Teacher C-1 could have rephrased several SATIC 9 (clarifying or interpreting) responses into SATIC 11s (asking for clarification or elaboration). A habit of recording oneself (discussed in the Interview section below) would assist Teacher C-1 in recognizing these interactions and reflecting on ways to reword responses to increase student-centeredness.

**Non-verbal Behaviors:** For several minutes during discussion or interactive presentation, Teacher C-1 would stand at the front of the room during reviews of student work and activities. He could have moved back and forth among the student desks more often during these entire class discussions. Such behaviors would have increased his interactions with students and helped him monitor learning, as promoted in ISU SSTEP. Two detrimental habits Teacher C-1 exhibited were inappropriate wait-time II (SATIC 13b) and using an annoying mannerism (SATIC 15) such as “okay?” and “all right?”

Inappropriate wait-time II (SATIC 13b) occurred five times in the second lesson and five times in the third lesson. As mentioned elsewhere, Teacher C-1 identified his tendency to hurry through the third observed lesson and related it to the limited time to address concepts at the end of the semester. His tendency to speak again before giving students 3-4 seconds after their comment typically accompanied his response of repeating student comments (SATIC 8) or clarifying/interpreting student comments (SATIC 9). For example, when a student shared an idea, Teacher C-1 would immediately respond with a SATIC 9 such as “So
what you’re saying is . . .” and say the definition he had in mind for a concept. This sort of response also included ending with an annoying mannerism (SATIC 15) such as “okay?” or “all right?”

Teacher C-1’s voice was strong but not overpowering, catching students’ attention and waiting for them to listen to him before he speaks. He also used pleasant facial expressions (smiling, eye contact) and body language (nodding, counting on his fingers) to encourage student involvement and comfort. Teacher C-1 used humor to increase the comfort level of the classroom. For example, during the bird/beak activity on lesson two, Teacher C-1 would move from group to group and comment on how “hungry” students were. He kept the pace of the activity moving to keep students engaged and on task. When some students complained they couldn’t keep up, Teacher C-1 would joke, “Natural selection doesn’t wait for anyone.”

At times, instead of writing on the board or making statements, Teacher C-1 could have encouraged more student engagement by having them increase their involvement in these actions. This was particularly true in the third observed lesson, which featured an interactive presentation on natural selection. Students had just worked in small groups to read and share summaries of concepts with each other. Rather than Teacher C-1 writing a summary of these concepts on the board, he could have asked students to take part and write or lead the discussion. He had used such a strategy during the first observed lesson on meiosis. Such a decision reflects research on student learning and the promotion of goals taught in ISU SSTEP. Again, Teacher C-1 acknowledged this discrepancy of practice with his research-based framework for teaching. As mentioned above, Teacher C-1 cited
constraints of time and the nearing end of semester for his reasons to address the content in such a short time span.

**Perceived Goals for Students**

In responding to the on-line questionnaire, Teacher C-1 listed six goals he currently has for his students. Four of these have the most emphasis:

a) *Students will take ownership of learning (#8)*
b) *Students will apply science to other fields of study and the outside world (#6, #12)*
c) *Students will understand the nature of science (#3)*
d) *Students will show clear understanding of science concepts and methods (#2, #11)*
e) Students will exhibit creativity (#7)
f) Students will show ability to work well individually and collaboratively (#5)

Teacher C-1 had his two biology classes (43 students) complete the goals questionnaire. As seen in *Figure 19*, the only goal that had an average response lower than a score of 4 (less than “much”) was #8: Students will set goals and/or self-evaluate (mean = 3.98, SD = .963). All other goals had an average score higher than a rank of four; in other words, the average of student responses is that these goals are promoted much or very much in the classroom. Students displayed positive, productive interactions with each other as they shared ideas and worked in groups. Discussion and reflection on ideas, though, was not as frequent as discussing procedures and “doing the work,” for example in the birds/beak activity.
The above student responses align with data acquired through classroom observations, teacher artifacts, and the teacher interview. Goals primarily promoted are self-confidence (#1), nature of science (NOS) understanding (#3), communication and cooperation (#5), creativity/curiosity (#7), a positive attitude about science (#9), using science resources (#10), and developing a deep understanding of fundamental concepts (#11). Teacher C-1’s classroom walls featured student-made posters debating the tentative yet durable nature of science, the role of creativity, the roles of invention and observation. Students also used creativity to craft posters and diagrams highlighting the history of understanding DNA. These projects indicate Teacher C-1’s explicit attention to NOS concepts such as the historical and social impact, science as a human endeavor, the tentative and durable nature of science, the role of creativity, and more. Goals not overtly promoted during observations or in artifacts were working towards solutions to local, national and
global problems (#6) and demonstrating an awareness of the importance of science in many careers (#12), though the DNA posters do indicate some investigation into science careers. Through observing the actions of both Teacher C-1 and his students, one can detect promotion of developing not only science skills and understanding, but also traits and techniques that equip individuals for life.

**Interview**

Teacher C-1 indicates an awareness of why he is doing certain strategies in the classroom. Reflecting on his experience in ISU SSTEP, Teacher C-1 highlights the importance of his goals and having a research-based framework for his practice:

I usually try to look at things that can really work—on stuff that can maybe scaffold off of stuff we have already talked about. Stuff that number one they can apply to their lives and have some importance to them, and then getting deeper off of that and not really focusing necessarily on memorizing all of the key concepts. Being able to apply some of the major concepts and focusing on grasping the four or five key things out of the chapter that I want them to know and then evaluating them on that.

As far as teaching, you have to be able to stand up and talk and defend a lot of stuff . . . It really goes back to student learning and just having those goals in mind. You have something to strive for.

Teacher C-1 shows reflection into his practice and the challenges of his profession:

With teaching there are a lot of other things that kind of sidetrack you from the goal a lot of times. But ultimately those are what you should be striving for and that’s the main aspect I think should be appropriate. Are the students taking ownership for their learning? Are they developing a strong understanding of what’s given to them?

Teacher C-1 was aware of discrepancies between his actions in the classroom and his ideal state. For example, he knows he wants to spend more time and focus on concepts with students even as he struggles to meet the needs of time constraints for the school final exam schedule. Constraint comes from working with his colleagues and within the confines of the
school schedule. Teacher C-1 discussed his experiences and means to circumvent these 
barriers:

In my department I have six people that teach biology. And at the end of the semester we all have to be at the same place in the curriculum. Ultimately, that’s teaching almost twelve chapters out of the book, which is a lot of material. At first I was very overwhelmed with it, trying to figure out how I am going to teach this much stuff and really getting in depth. I tried to focus on what stuff that I really need to teach, and what stuff I cannot focus on so much. I think that is probably the biggest thing—what types of things do [the students] need to know. I need to get the major stuff in of those sections—just making sure that I have a focus on those goals and follow them and having the kids learning something rather than trying to speed rush through it. And sometimes, when things are going along like days off or break or even assemblies and things. And you have to go through that much stuff, it has a huge effect on what type of stuff I can get in there and if I need to cut stuff right now or what.

It’s a struggle, that’s for sure. In my situation, if I was the only teacher I could go into a lot of that stuff deeper. But when we have to get to a certain point—the thing about it is at semester a lot of our students switch teachers. And so if they are starting [after the semester break], the stuff we are doing leads up to where we are at right now [at the end of the first semester], and it’s a struggle.

In light of this struggle with institutional constraints, Teacher C-1 recognizes he could do more tasks to improve his situation. He also recognizes he is not where he could be, reflecting on his experiences through ISU SSTEP:

Taping myself was a big time help. I haven’t done it, to be honest with you, since my first year. But I think that was a very valuable thing to learn how I’m teaching. Checking out my question sequence and seeing how I interact with the students is probably one of the most valuable things. I wish I would do it more. I just haven’t gotten around to it. I haven’t done any recently and I probably should because I have probably gone away from some of the stuff I was doing.

Teacher C-1 indicates awareness of his own tendency to slip into less productive teacher behaviors. He cites specific SATIC codes that he wants to limit (dichotomous 3a, short-answer 3b). Teacher C-1 recognizes his ability to ask the desired open-ended questions more often when students are working in groups, and his need to use the same sort of questions
when speaking with the entire class or introducing a topic. He describes actions (intended and actual) to improve his practice:

Number one would probably be taping myself. I need to get a chance to do that again. I’ve been meaning to do that and I have my intentions of doing that. I am also just being conscious of each day when I am doing stuff. Writing down the questions that I want [the students] to focus on. I usually do that. I usually write down the questions that I want them to be aware of and what I want to ask them and the types of responses I would like to see . . . try to be a little bit prepared on what to expect from them.

I’ve been to a couple different conferences as far as working on the differentiation in the classroom. I have collaborated with other teachers as far as you know what they are doing and what materials [they use]. Those are the main things I have been doing to try and improve.

Teacher C-1’s words indicate an astute awareness of his current teaching practice. He recognizes he could do specific tasks to improve. Although Teacher C-1 does not everything he could, he does show evidence of some purposeful attempts for improving and identifies additional tasks for further improvement.

Artifacts

The activities Teacher C-1 uses are often introduced with a half sheet of paper. These handouts include sections describing the purpose of the assignment, the task or assignment itself, and a scoring guide or rubric of expectations. Nearly all assignments require working with a group or partner. The tasks are open-ended, with students being given a problem or task and having to use their own creativity and problem solving to complete the task. Students often complete hands-on models that depict science concepts (atom model making, cell cycle poster, stages of meiosis, etc.). Assignments also feature a moment of sharing ideas and creations with other students by presentations or posters. For one assignment, students are given one “tenet” or core statement about the nature of science, with which they
must research and identify key components. They then organize their findings and summaries on poster paper and present to their classmates, along with any other models they choose to best communicate their ideas and information. Communication is promoted through by having students ask questions of other groups, pick viewpoints to support and debate, and create concept maps and analogies for science concepts such as functions of cell organelles. Only one handout appeared to be taken from a textbook publisher. This worksheet featured a fill-in-the-blank of various DNA amino acid sequences, identifying traits based on a given data table, and coding the mRNA and tRNA sequences.

Unit tests include a variety of assessment items. Each test has approximately 20 multiple choice questions requiring students to identify generalizations, relationships, definitions, and exceptions to concepts. These questions appear to promote some memorization of content that may not require deep understanding. Other multiple choice questions require more than surface memorization, as students have to apply a concept to choose an answer or synthesize information to complete a statement. The second half of the exam (about 12-15 questions) requires students to complete short answer and essay questions. Other questions are labeled specifically “interpreting graphs,” “inferring,” “applying concepts,” “predicting,” “comparing and contrasting,” “problem solving,” and more. These questions are in a section titled “Using science skills.” Students are given experimental data such as a table, diagram, or line graph. They then write answers to open-ended questions about these paper investigations. Often, questions include applications to news items, medical advances, or health issues. This is true mostly for the short answer and essay questions.
Summary

_Habits of Understanding:_ Habits of understanding exhibited by Teacher C-1 indicate a high match (H) to ISU SSTEP. Teacher C-1’s rationale for his lessons, his in-class decisions, and his shared insights about his goals for students practice match with the considerations promoted at ISU SSTEP. This is further illustrated by C-1’s awareness of institutional constraints and his manner of adapting to these barriers. Artifact analysis indicates Teacher C-1’s deep understanding of using meaningful assignments and projects that engage students in thinking, draw out their ideas, promote goals, and have worthwhile results and application.

_Habits of Action:_ With respect to habits of action, Teacher C-1 has been rated as having a moderately high (MH) match to the ISU SSTEP program. This is exemplified by C-1’s consistent high marks on the COP rubric with respect to teaching lessons that promote high levels of inquiry, student discussion, participation, and intellectual engagement. Teacher C-1 uses several activities that foster his student goals and promoted engaged learning, as opposed to surface memorization or recognition of content. The habit of action is not a completely high match due to C-1’s tendency to use teacher-centered responses, inappropriate wait-time II, and simple questions at times when open-ended questions could be asked.

_Habits of Reflection:_ Teacher C-1’s habits of reflection have a high match (H) to ISU SSTEP. Much like Teacher C-1’s habits of understanding, his reflection represents habits of ISU SSTEP through articulating his decisions during the lessons and their impact on students’ learning. He notes the effect of moving through content too quickly. Despite meeting the needs of aligning with the semester schedule, Teacher C-1 reflects on the need to
take more time and review key concepts (such as natural selection) with his students. Teacher C-1 identifies the pressures to align with his colleagues, and consciously negotiates through this process to meet both department expectations and his own research-based framework for science teaching. Teacher C-1 also notes the importance of his classroom interactions and the need to audiotape himself to have a clearer idea of these behaviors.

**Habits of Improving Practice:** With respect to habits of having and following an action plan for future improvement, Teacher C-1 has a moderately high match (MH) to the habits promoted by ISU SSTEP. He quickly recognizes several actions he can take to improve. Teacher C-1 is currently doing some of these actions (thoughtfully planning and writing questions for lessons, attending multiple conferences, collaborating with colleagues). Teacher C-1 identifies other plans to improve (tape recording his teaching and coding his interactions). Although he has taped himself in past years, he admits he needs to be doing this more often to improve.

**Overall Alignment of Habits with ISU SSTEP:** With respect to a summary rating, Teacher C-1 exhibits an overall moderately high (MH) match to the habits promoted and modeled in ISU SSTEP. Teacher C-1 exhibits thorough understanding and reflection in his teaching. He also exhibits habits of action that closely resemble the behaviors and practice promoted by ISU SSTEP. However, Teacher C-1’s behaviors do have some tendencies that limit the amount of student engagement and the teacher’s ability to assess understanding. Teacher C-1 readily identifies these behaviors and what he could do to improve. Some actions he is currently taking, some he is not. He also recognizes his need to follow through with an action plan that can sufficiently address and improve these behaviors. Teacher C-1’s
three years of experience and three years’ removed from ISU SSTEP may contribute to this moderately high match of habits of action and plan for future action.

*Teacher C-2: 2nd Year Teacher (Current Program, MAT)*

**Overview**

Teacher C-2 teaches two sections of 7th grade life science and two sections of 8th physical grade science in an urban, inner city K-8 school. In the afternoon, he acts as a “peer coach” for K-8 science in his school. He documents the science content learned by the students as they progress from each grade from kindergarten to 8th grade. While only in his second year of teaching, he also works with the K-8 teachers in his building to provide different resources and ideas for effectively teaching science.

The challenges of teaching in a community experiencing poverty and apathy actually afford opportunities to reveal Teacher C-2’s abilities and understandings. He creates a classroom environment of calm and mostly disciplined learning, making use of a calm voice, relaxed pace, and humor to create a welcoming, comfortable environment. Chairs were arranged around pairs of tables, so that students work in groups of 4-6 around those tables. An African-American woman para-educator assisted Teacher C-2, playing almost a “mother/grandmother” role to the kids, most of whom are also African-American. This para-educator was quick to assist in managing student behavior such as telling a student to sit up, get out materials, and other behaviors.

**Content, Activities, COP Coding**

Teacher C-2 was observed teaching three lessons, although the second observation took place over two class periods. For the most part, the science content taught to students in Teacher C-2’s class appeared to be developmentally appropriate. The deeper meaning
behind concepts sometimes extended beyond these 7th and 8th grade students’ ability to grasp. Examples are how these concepts came to be developed and the evidence and reasoning that support them. Nevertheless, content was typically taught at a deep level, as opposed to surface memorization. However, some memorization of terms was expected of students, and fruitful opportunities to apply concepts to “real world” issues were sometimes missing. The first lesson observed included mostly review and memorization of vocabulary of plant reproduction. Students were engaged in this first lesson, but the focus was on terms rather than concepts; hence, the lower overall COP ratings for this observed lesson (See Figure 20).

![Figure 20: COP coding for Teacher C-2](image)

*Maximum Capsule rating is 8; all other categories have a maximum rating of 5*

This emphasis on terms and recitation in this first observation was in stark contrast to the other two classroom observations and the classroom artifacts collected from this teacher.
Furthermore, each lesson included reflective learning in the form of journals, class discussions, and testing ideas through hands-on exploration. More typically, Teacher C-2 used materials and structured lessons to mentally engage students. For example, Teacher C-2 was observed including flowers for examining reproductive plant organs; and tuning forks, water trays, and a guitar for learning about sound and waves. Experience consistently occurred before and during discussion and investigation of ideas. Teacher C-2 then continually revisited these concrete materials and occasions as the students consolidated ideas about the concepts illustrated by these experiences. As students shared more ideas, Teacher C-2 would encourage additional exploration. For example, during the third observation, students investigated the transfer of sound waves through aluminum can/string telephones. When students inquired about the structure of the devices, Teacher C-2 brought out a larger scale “telephone” made of string and two empty, open plastic cat litter jugs. Students were then encouraged to investigate and compare the devices, and even combine them by overlapping string and producing sound. The use of common materials (cans, string, plastic jugs) promoted the notion that science investigations are not limited to the laboratory or complicated technology. Rather, students could use familiar equipment to investigate phenomena.

**Teacher Behaviors and SATIC Pattern**

Classroom management was handled smoothly on most occasions, notable due to the tendency for apathetic students. Teacher C-2 worked with students at both ends of the spectrum—some who were docile and others who could barely stay in their seats as they answered and asked questions. The pattern in both of these periods, though, was nearly identical in terms of types of SATIC questions and responses.
**Questioning:** Teacher C-2’s initiatory behaviors with his students typically consisted of a mix of SATIC 3a/b/c/4 questions (See Figure 21). Within the talking category, most were making a statement or rhetorical question (SATIC 2). Most (8 out of 14 total, 57%) of these incidents occurred during the first observed lesson, which focused on vocabulary of plant reproduction. Teacher C-2 asked several SATIC 3a and 3b questions (58% of all questions asked) that constrained students’ thinking and the ensuing discussion, particularly in the first classroom observation. These 3a and 3b questions could be rephrased as 3c or 4 questions that would have more effectively engaged students, a habit of action promoted by ISU SSTEP. For example, rather than asking students to define the function of the stamen, Teacher C-2 could have asked how the stamen’s function compared with those of the pistil.
A follow-up question could ask how these plant organs’ structures relate to their functions. Or, instead of asking for students to identify wavelength, Teacher C-2 could have asked students how wavelength relates to frequency. The latter question evokes deeper thinking and requires students to compare and relate concepts along with identification.

**Responding:** As seen in *Figure 21*, Teacher C-2 used more student-focused responses (SATIC 11 and 12; 32 total incidents; 56% of all responses) than responses that limited student engagement and assessment (SATIC 5, 7-10; 20 total; 35% of all responses). His most common responses were asking students for elaboration or clarification (SATIC 11; 22 incidents; 39%), repeating student comments (SATIC 8; 10 incidents, 18%), and using students’ questions or ideas (SATIC 12; 9 incidents; 16%). Teacher C-2 acknowledged students’ comments (SATIC 6) with “okay” a total of five times (9% of all responses), never more than twice in one classroom lesson. This form of neutral acknowledgement was never enough to become an annoying mannerism, and Teacher C-2 also acknowledged students through non-verbal responses as well such as nodding, smiling, and counting on fingers. The first observed lesson featured the fewest responses asking for elaboration (SATIC 11; 3 incidents) or using students’ ideas (SATIC 12; zero incidents). This is partly due to the first lesson’s emphasis on terms and vocabulary, rather than investigation of concepts and ideas. Half (10 out of 20) of Teacher C-2’s teacher-centered responses (SATIC 5, 7-10) were repeating student comments (SATIC 8). This was not due to progressing through the lesson and discussion too quickly, as Teacher C-2 taught at a relaxed pace throughout all observations. The repeating of student comments was not due to too much classroom noise, as the relaxed atmosphere was calm and quiet. Rather, Teacher C-2 responded by repeating students’ questions and comments since many spoke in quiet voices. Teacher C-2 could have
chosen to not repeat comments and instead afford the opportunity for other students to ask their peers to speak up or repeat themselves. This behavior was taught in Teacher C-2’s ISU SSTEP experience as a way to encourage more student dialogue. The second most frequent response (7 incidents) was confirming or praising student comments (SATIC 7). Most of these responses occurred during observation one, when Teacher C-2 praised students for correctly defining or identifying terms. As Teacher C-2 learned through ISU SSTEP, praising students limits their contributions and the teacher’s ability to assess. As with repeating student comments, the excessive use of praise in the first observation lesson coincided with the lesson’s emphasis on terms rather than concepts. During the latter two observations, which featured investigation of concepts, Teacher C-2 also responded to students by writing down their ideas for questions such as “What causes waves in oceans?” As taught in ISU SSTEP, Teacher C-2’s nonjudgmental recording of these ideas communicated value to students’ contributions. The written list then acted as a starting point from which to further both investigation and discussion.

**Non-verbal Behaviors:** Teacher C-2 used a variety of behaviors for encouraging students to share their ideas. He moved about the room in an L-shaped motion from one corner of the room to the other. The two sides of the room where Teacher C-2 typically stood were the two walls that have whiteboards. During student exploration in small groups, Teacher C-2 spent his time moving among the tables with the students. He was quick to smile, joke, or say a funny comment in a funny voice to encourage humor and comfort. His facial expressions included inquisitive raised eyebrows and eye contact during discussions. These non-verbal behaviors communicated interest in the students’ ideas about the science content. Along with nodding at student comments, these non-verbal behaviors showed
acknowledgement of student answers without speaking “okay” or other words (SATIC 6).

Wait-time I and II are appropriate, typically lasting three to four seconds minimum. During the second observation, Teacher C-2 used inappropriate wait-time I once, not waiting for student answers after a question before asking another question. Non-verbal behaviors also included using the body to model science concepts. For example, Teacher C-2 had his students raise their arms as he did to represent a tuning fork. Then he asked them to show what happens to produce sound and how this affects the surrounding air molecules. Teacher C-2 then proceeded to join the students in mimicking behaviors to represent compression and decompression of wave movement.

**Perceived Goals for Students**

In the on-line questionnaire, Teacher C-2 listed seven goals that he currently has for his students, four of which are most emphasized:

a) *Students will have a deep and robust understanding of science and scientific principles (#11)
b) *Students will understand the nature of science (#3)
c) Students will consistently self-assess their progress (#8)
d) *Students will show respect through their behaviors and actions (#5)
e) Students will become productive members of society (#6)
f) Students will be competent and informed when making social decisions (#5, #6)
g) *Students will incorporate critical thinking skills into all of their decision-making (#2, #8)

Teacher C-2 gave his goals questionnaire to his 7th and 8th grade classes (51 students). As seen in *Figure 22*, two goals had an average response lower than a score of 4 (i.e. promoted less than “much”). These were Goal #6: Students will participate in working towards solutions to local, national, and/or global problems (mean = 3.82, SD = .932) and Goal #11: Students will demonstrate deep understanding of fundamental science concepts
rather than covering many insignificant/isolated facts (mean = 3.90, SD = .878). All other
goals had an average student response of being promoted between levels of “much” and
“very much.” Goal #6 was not promoted in any of the observed classrooms. Goal #11 was
promoted extensively in two of the three observations. The one exception included a lesson
on flower anatomy vocabulary. Student goals extensively promoted in all observed lessons
were conveying self-confidence (#1); using critical thinking skills (#2); setting goals and
self-evaluating (#8); and accessing, retrieving, and using resources in the process of
investigating phenomena (#10). Goals promoted extensively or moderately promoted in
nearly all observations included identifying and solving problems (#4), using communication
and cooperation (#5), understanding the nature of science (#3), being creative or curious (#7),
conveying a positive attitude about science (#9), and demonstrating a deep understanding of
content (#11).

Figure 22: Student goals questionnaire results for Teacher C-2 (N = 51)
Evidence from classroom observations, teacher artifacts, and the teacher interview support the above summary. While not all that can be shared here, the following illustrates the kind of evidence used to support the contention that particular goals are promoted. Teacher C-2 was observed every time beginning class by having students write their thoughts about a science concept (e.g. “Describe and draw a picture of how sound travels through a medium”) to engage them in thinking and on task behavior. Teacher C-2 was proactive in engaging students in thinking and working by asking them what they could do to remember information, how they should behave when one person is sharing, etc., explicitly teaching them such skills. Reference to the nature of science (NOS) was made at times during the three observations. For example, explicit attention was given to how scientists record and share information as they perform investigations. Implicitly addressed NOS traits were the tentativeness of science, reaching consensus, and the role of creativity in science investigations.

Interview

Teacher C-2 cites to his goals when explaining how he plans and evaluates his teaching. He refers to his research-based framework he composed during his ISU SSTEP experience:

A primary part of my RBF that I use are my goals for students. They’re very personal and research-informed. That is huge. Also, individual teaching practices that are supported by research-based sources.

When asked why his goals are important, Teacher C-2 elaborates to their value in his teaching and planning:

I think [it’s] the personal nature of your goals. I mean, when they’re actually designed by the teacher, influenced by the research, morality, and goals of the society, that kind of hits home. And maybe you can actually take greater ownership
of your goals in that way. It’s really what you believe in, so it’s not like someone is taking up a piece of curriculum and saying, “Oh, this is the best way to do things. You should teach this way right now.” I mean, they’re yours. So if you can’t believe what you preach, you’re in trouble. [laughs]

Goals were a major theme of the ISU SSTEP experience through Teacher C-2’s multiple semesters of science teaching methods. Other aspects formed the framework of a research-based approach promoted in the program. Teacher C-2 alludes to these components and how they inform his teaching and planning. He also notes the role of this district’s standards and how he deals with these:

[In this district], we have a curriculum map that they’ve agreed to address. And first of all, I look at that and I evaluate what is important as far as the overall growth of students. Also, when looking at my goals, I basically say, “Well, is it the appropriate time to introduce material? Have they been thoroughly introduced at a prior grade? Do we need a refresher?” Also, I want to make sure that my courses are challenging and rigorous, but at the same time that it’s not overkill. I don’t want to teach middle schoolers senior physics in high school, but I want to be doing it at a level appropriate, developmentally appropriate for the students. Those are all things I consider. But for the most part, my goals have a big huge part of it, as far as not what exactly what I’m teaching, but how I teach it.

Teacher C-2’s goals again become a vital ingredient for his planning and teaching. He clarifies how these goals for students guide his thinking by asking himself several questions:

Am I encouraging these students to self-assess their progress? Am I encouraging these students to think critically? Am I encouraging these students to be leaders socially and be scientifically informed? A lot of these goals can’t be met just by having the students read out of the textbook and answer questions. So, types of things we do, whether it’s our group work or whether it’s some of our odder activities [laughs], they ought to really encourage the students to think and challenge themselves.

When asked about his current teacher behaviors in the classroom, Teacher C-2 does not reflect on his use of questions or responses with students. Rather, he refers to general traits he sees as valuable:
I think it’s important to be accessible to students. They don’t want a person who is going to be up there like some stoic preacher and just preach at them. You have to be on the level of understanding where they’re coming from and have them understand who you are. So it’s definitely important that you set up a rapport with your students. So I mean, typically I use a lot more jokes and things of those sort, try to keep it light, try to keep it humorous. And always try to structure it so that they all have something to contribute, even if they don’t have a whole lot of content knowledge.

Teacher C-2 clearly exhibits consideration for the learners, though he does not readily articulate on his particular interactions with students. His vision for his desired state includes similar generalizations that give special concern to his students:

I think we [teachers] all want more patience at times. That’s something you can strive for. There’s always those days where behaviors and certain things can push you to the point that you don’t want to be as a teacher. So, more patience and learning how to diffuse situations more quickly. It comes from experience for the most part. To be able to predict what’s going to happen before it happens a little bit better.

Interestingly, Teacher C-2’s reflection about his improvement readily identifies the value of experience but excludes the very habit of reflection itself. Nevertheless, he does describe his current actions to improve his teaching.

I do a lot of collaboration between teachers in my middle school. That’s really nice that we can talk with each other and ask each other how things are working, how these students are behaving in other classes. So we can really find out whether it’s just the student and their behavior all the way around, or if it’s just their relationship with a particular teacher. And that’s really nice because then you can examine why are you and the student relating this way? And what can you do to change it? And you really assess it at a student-by-student level.

Collaboration with colleagues to compare student experiences constitutes the amount of action reported by Teacher C-2 with respect to improving his classroom interactions. He does exhibit additional behaviors that typify a habitual action plan for improvement.

As far as professional development, there’s a lot of district things I end up going to . . . some of them worthwhile, but some not so, of course. I need to get to a couple more national meetings. But other than that, I read a lot of journals—*Science Teacher*, *Science Scope*, and the elementary one [*Science and Children*], because in the
afternoons I do a little consulting with the other teachers. I integrate a lot of the elementary stuff.

I continually read up in science journals, pretty much I do it on my own time. I try to read and catch up on things that I could do differently in my class to support my goals and ways that I could do it, to kind of streamline the whole process and also make it more beneficial to the students.

For Teacher C-2, efforts for improving himself have the purpose of helping students in both his and other colleagues’ classrooms: “I keep well-read on the research in different areas. And I work with other teachers to assess student needs and relationships.” Despite his interactions with colleagues, Teacher C-2 does cite school administration as being potential barriers to improvement. This type of institutional constraint is not necessarily in the form of opposition, but rather neglect. When asked why he might ever leave the profession, Teacher C-2 states, “It’s primarily increased expectations from administration with a lack of support.”

**Artifacts**

Teacher C-2’s class materials include projects requiring research into scientists and historical contexts of science. Students prepare presentations and write one-page papers about various scientists and concepts. Teacher C-2 gives students a slip of paper with a 5-10 line paragraph highlighting the required information and components of these projects. Some of these projects require students to mostly follow the expectations to finish their projects, with somewhat limited effort in problem solving, creativity, and critical thinking. Students also have labs such as frog and plant dissection. These activities are mostly procedural containing “Background” conceptual information and “To Do” instructions in the activity. These lab activities do feature questions inserted throughout that ask students to elaborate on their ideas. Examples are “Can you think of other ways that cross-fertilization of flowers might happen (besides by the wind)?”, “Why do you suppose the petals of flowers
are so colorful, fragrant, uniquely shaped?”, “Notice the eyes of the frog are located on the top of his head. What advantage would this give the frog when it is in the water?”, and “What do you think the frog uses its teeth for?” Other questions require recall such as “The wind pipe is called the ___?” and “What is the job of the kidneys?” Another lab about heating and cooling asks students to consider what colors of clothing they want to avoid wearing on a hot day, as well as how the materials in the lab relate to the biomes they have been studying. Assessments indicate emphasis of critical thinking, problem solving, and deep content understanding. Paper tests feature an average of 15 open-ended short answer or essay questions. Some ask for examples or definitions of concepts, while others ask for explaining differences, comparisons, or applications.

**Summary**

**Habits of Understanding:** Teacher C-2’s habits of understanding are a high match (H) to the ISU SSTEP. This is indicative by Teacher C-2’s reference to his goals, students’ developmental levels, prior knowledge and experience, district expectations, and more considerations when planning and teaching his lessons.

**Habits of Action:** Curriculum and instruction in Teacher C-2’s classroom constitute a high match (H) to the ISU SSTEP for habits of action. Teacher C-2 promotes investigation, discussion, and exploration of ideas through a variety of well-paced activities within his class periods. Artifact analysis and a review of promoted goals provide additional evidence of a high match between Teacher C-2’s actions and those promoted at ISU SSTEP.

**Habits of Reflection:** A moderate (M) match exists for Teacher C-2’s habit of reflection. He does not reflect on precise components of his instruction such as questions, responses, and non-verbal interactions. Furthermore, Teacher C-2 does not report audio- or
videotaping his teaching. He does, however, reflect on how his behaviors impact student learning and his promotion of goals for students.

**Habits of Improving Practice:** Teacher C-2’s habits of improving practice have a moderately high match (MH) to ISU SSTEP. Like his reflection, Teacher C-2 does not address specific action he takes to improve interaction patterns such as taping and listening to his teaching. He does commit effort and time to read science teaching journals and collaborate with colleagues. One might contribute this commitment to his job description as science peer coach in his building. However, Teacher C-2 gives his time to these efforts on his own time. His attendance to professional development includes a critical eye toward what is most beneficial to his students.

**Overall Alignment of Habits with ISU SSTEP:** Teacher C-2’s overall summary rating is a moderately high match (MH) to the habits and actions promoted in ISU SSTEP. His actions and understandings lead to success in an urban classroom, despite its unique challenges. Though some of his reflection and improving practice habits lack specificity toward his teaching behaviors, Teacher C-2 exhibits a mindset for improvement based on a solid understanding and ability for effective science teaching. The very fact that Teacher C-2 is a second year teacher in charge of an entire building’s science curriculum also matches with goals of the ISU SSTEP to produce leaders in science education.

**Teacher C-3: 2nd Year Teacher (Current Program, MAT)**

**Overview**

Teacher C-3 teaches 6th Grade General Science at an urban middle school. His classes were diverse in ethnicity and include students from middle to lower-middle class families. Teacher C-3’s classrooms were boisterous and full of energy and noise. Teacher
C-3 himself used a quiet demeanor, though he fosters this environment of free speaking and “fun.” Classroom management was the primary barrier to successful learning, as students’ energetic behaviors and freedom to express themselves border on disrespect (for each other more than for the teacher). Unproductive chatter was nearly continuous during the class period, along with interspersed engaged thinking and sharing. Rather than listening and discussing ideas, students mostly shouted out their responses and questions, often at the same time and often while half of the class was distracted by talking with peers about their own ideas or off-content topics. Chairs were arranged around pairs of tables, so that students are arranged to work in table groups of 4-6. Student-student interactions were encouraged, but behaviors often lacked appropriateness and productiveness. The students’ young age is a logical correlation to less stringent and organized interactions, although more organization and accountability could still be taught, learned, and developed.

**Content, Activities, COP Coding**

Content taught during the three observed lessons was primarily physical science concepts. The first observation lesson was a day of consolidation after previous exploration with the solid-liquid “Oobleck” cornstarch/water mixture. In groups of four, students summarized their ideas by writing on desktop-sized whiteboards and composing Venn diagrams with descriptions of the slime’s solid and liquid properties. Groups then took turns sharing their Venn diagrams with the rest of the class. During the group work and class discussions, Teacher C-3 mostly listened and observed. He would occasionally pose a question to students, as discussed below in *Teacher Behaviors and SATIC Pattern*. Teacher C-3’s interactions with the students helped to draw out ideas and focus thinking on concepts as opposed to managerial choices (who gets to write, who can share their idea next). Student
consolidation of ideas was the common practice in Teacher C-3’s classroom, hence the relatively high COP ratings for Design, Culture, and Capsule categories. In addition to Venn diagrams, Teacher C-3 also used the group whiteboards with students for brainstorming and organization of data. Students then presented their whiteboards to the class and asked questions. This process was occasionally short-circuited by the lack of listening by most students. Teacher C-3 asked questions and encouraged his students to ask questions to steer their attention to learning, as opposed to playing with the whiteboards at their tables.

Observations two and three were successive lessons on chemical elements and the periodic table. The extent to which this content was developmentally appropriate is suspect. In observation two, students focused mostly on the “what” of protons, electrons, neutrons, atomic number, atomic mass, and electron placement of elements. The degree of learning about these atomic features was limited to surface memorization, although students did develop the skills to determine the amounts of these parts for given elements. For example, if given the element and atomic mass, the students could determine the other components. Nevertheless, the concepts themselves were too abstract for 6th grade students; developmental inappropriateness is one reason for the lower rating for the COP Content category (See Figure 23).
Teacher C-3 promoted inquiry and nature of science (NOS) in the third observed lesson. Students learned about the patterned organization of elements in the periodic table. Again, while students may have not completely understood the concepts of electron arrangement and periodicity, they did learn about the patterns and common traits in element placement. Teacher C-3 began this lesson with an open-ended activity challenging students to organize twenty paper cards that each had a name of an animal. Students worked in their groups of four to create an organizational scheme for these creatures. Near the end of the class period, Teacher C-3 had the student groups each present their way of sorting the animals to the rest of the class. Even though student groups used all of the animal cards, some had holes in their tables, similar to the early periodic table developed by Mendeleev.
Teacher C-3 asked the students to describe the characteristics of the animals they think would best fill the holes. Students were engaged in this creative, collaborative, thought-provoking activity, with an experience from which they could learn about the historical evolution of the Periodic Table of the Elements.

Teacher C-3 experienced some difficulties in lesson implementation, maintaining engagement and learning with all students. Content appropriateness was also an issue with these younger students. Nevertheless, all three observed lessons fostered investigative science, active participation, and idea consolidation from the students. Hence, the COP category ratings are all relatively high (See Figure 23).

**Teacher Behaviors and SATIC Pattern**

Compared to other teachers observed in this study, Teacher C-3 had fewer interactions with the students as a class. He was typically quiet and listened to students as they shared their ideas with him and their classmates. Teacher C-3 would give instructions and often had to stop and get the entire class’s attention by saying “listen” (roughly half of his ten SATIC 1 incidents over three observations). As a sign of his creativity, Teacher C-3 more frequently would get the class attention by asking students to give him a “whoop whoop” in unison. The latter was a student-favored method to have everyone quiet down. However, students often began chatting away soon after doing this attention-getter. Most of Teacher C-3’s interactions occurred at individual or small group levels, typically when students work on their projects or the activity.

**Questioning:** During his interactions, Teacher C-3 used a mixture of initiatory questions. As seen in Figure 24, the ratio between simple questions (SATIC 3a, 3b) and
open-ended questions (SATIC 3c, 4) was roughly even. In three observations, Teacher C-3 asked 15 simple questions and 17 open-ended questions.

![Figure 24: SATIC coding for Teacher C-3](image)

**Responding:** Teacher C-3’s typical response to student comments was by asking students to clarify or elaborate on their ideas (SATIC 11; 18 incidents in three observations). Asking for elaboration, together with using student ideas (SATIC 12; 1 incident), account for 75% of all of Teacher C-3’s responses (See Figure 24). Three incidents of acknowledging student comments (SATIC 6) occurred in the third observation, during which Teacher C-3 said “okay” to students as he listened to their ideas for arranging the animal cards. The only teacher-centered responses recorded in the three observations were three incidents of answering student questions (SATIC 10) in the third lesson as Teacher C-3 interacted with the groups working on their animal cards.
Non-verbal Behaviors: Teacher C-3 exhibited one instance of inappropriate wait-time I during the third lesson, not waiting roughly 3-4 seconds for a student response after he asked a question. Typically, Teacher C-3 was patient with his students and interacted evenly with groups throughout the classroom. He would move about the room between table groups and around the side of the classroom. The typical time for Teacher C-3 to remain at one table was 30 seconds, before moving on to another group. All students received attention through his interactions. Teacher C-3’s body language showed enthusiasm to interact with students and hear about their ideas, moving a hand to his chin to give an inquisitive look. Whenever students gave presentations, Teacher C-3 would move to the other side of the room. This behavior promoted the presenting students to speak up and afforded Teacher C-3 proximity with students furthest away. Teacher C-3 also exhibited a quiet, but jovial demeanor through his “whoop whoop” attention-getting routine. Teacher C-3 often struggled to wait for students become completely quiet before continuing the lesson, which diminished some student attention. Still, this approach was a positive way to call students’ attention rather than traditional punitive methods. Teacher C-3 encouraged students to ask questions of each other and to share their own ideas, though, again, this practice is inhibited by the amount of non-productive student talk and noise in the classroom.

Perceived Goals for Students

On the on-line questionnaire, Teacher C-3 listed 11 goals he currently has for his students:

a) *Students will demonstrate critical thinking (#2)
b) Students demonstrate a deep understanding of science and apply this knowledge in their daily lives (#11)
c) *Students will demonstrate creativity and ingenuity (#7)
d) *Students will demonstrate respect and open-mindedness (#5, #9)
e) Students will be responsible and conscientious members of a community (#5)
f) Students will exhibit confidence to take risks and engage in learning (#1)
g) Students will set goals and evaluate their progress (#8)
h) Students will be active in their own learning.
i) *Students will work effectively in groups (#5)
j) *Students will understand the nature of science (#3)
k) *Students will be effective communicators (#5)

Teacher C-3 gave the goal questionnaires to all of his 6th grade science classes (110 students). As Figure 25 indicates, the average ranking was “very much” (4) emphasis or higher for seven goals. Three other goals had an average ranking just below this mark. The remaining two goals with the lowest average rankings were Goal #8: Students will set goals, make decisions, and self-evaluate (mean = 3.68, SD = 1.149) and Goal #6: Students will actively participate in working towards solutions to local, national, and global problems (mean = 2.89, SD = 1.237). The latter goal had an average ranking below the level of “moderate” (3) emphasis.

![Figure 25: Student goals questionnaire results for Teacher C-3 (N = 110)](image)
The above student questionnaire data is consistent with classroom observations, artifacts, and the interview with Teacher C-3. Deep understanding of concepts (#11) was extensively promoted through sense making about fundamental science content, developmental appropriateness notwithstanding. A positive, “fun” atmosphere existed in the classroom that encouraged student interest and enjoyment of learning and applying science (#9). Students were continuously encouraged to use creativity (#7), critical thinking (#2) and problem solving (#4) skills in investigating, organizing, communicating concepts and their understanding of them. Nature of science (#3) was modeled through inquiry, sharing of ideas, reaching consensus, and explicit examples. Student collaboration and communication (#5) were present and actively promoted, although students struggled to develop appropriate ways and means to do this, including actions such as listening, respecting each other, and truly examining and valuing each others’ ideas. Again, the primary hindrance to effective teaching was management issues. To foster more on-task behaviors and help in assessment, Teacher C-3 could have provided more questions, time limits, or challenges for the students during their group work and activities.

**Interview**

Teacher C-3 displays a thorough understanding of the habits promoted by ISU SSTEP as he describes how a research-based framework informs his approach to science teaching:

I usually look at [the schematic] of prior knowledge down at the bottom and the teacher strategies and materials and just trying to get student actions that are really trying to promote the student goals. That’s one of the main things that I always look at when I’m setting up a lesson plan. Because I think all these teachers keep getting away from these student goals as our main objectives and they’re too worried about getting a certain grade on something. To go along with that, just looking at those goals and what I’m looking for and the actions of those students, what they’re doing that actually promote those goals.
I also look at . . . the order of things, where you do the introduction activity, then you talk about the main concepts, and then you bring in the vocab and the reading at the end. I really try to stick to that, along with some kind of application activity. I just looked at it recently because I did my portfolio. And some of the things I’d change [in my original RBF] was why I went into teaching because I think it’s different now and it looks different. [This includes] classroom management. So it’s interesting to look at.

Teacher C-3’s latter comments indicate habits of reflection, revisiting his RBF paper as he fulfills his school district’s standards and professional portfolio. His attention to classroom management indicates a conscious effort to improve on this aspect of his teaching. Teacher C-3 elaborates on his habits of understanding and actions as he describes his lesson preparation process in further detail.

First I look at content, what content I have to teach. Then I can move towards what materials do I have and how I’m going to teach this content. And I like to look at it so I can teach it in a different way. I don’t like to be restricted from fun ways so that the kids are really going to understand. You need to know that these kids are coming from [in] the city and their background knowledge and what they know. And then just move into how you are going to teach [content] and how you are going to get [students] engaged. It’s harder to just hook them and get them engaged in this thing. And then what goals you are going to promote. Those goals actually get worked in there while you’re planning. Keeping the hands-on activities and really asking the questions.

When asked about his goals for students, Teacher C-3 explains why they are a vital piece of his planning and teaching. He uses his experiences as a schoolteacher to further enhance his rationale.

What makes [goals] so important is [teachers] don’t ever think of these as being our main objectives for students. It’s always been about doing well on a certain test or achieving academic goals and learning the content. [Having and promoting goals] help us focus on teaching a kid, not just a student. So we need to educate them on everything, not just our content area.

Teacher C-3’s perspective includes consideration for fellow colleagues in his school. He speaks of using his understanding and actions for improving practice to help other teachers.
This includes teaching the SATIC teacher behaviors coding tool to other teachers. He also looks to collaborate with other teachers to make interdisciplinary lessons. His interactions with colleagues are even more critical with respect to the school culture that promotes uniformity and traditionalism. Teacher C-3 explains how he works through this form of institutional constraint:

We have a core curriculum we have to stick with. You can kind of veer off on tangents. I like to veer off on tangents a little bit, just kind of work around it. And we’re supposed to go in order, a certain book order from one book to the next to the next. And yeah, that doesn’t happen. [laughs] I don’t like to keep that order. But that’s all right.

As Teacher C-3 shares reasons for his dissension to institutional constraints, he shows habits of understanding and action promoted by ISU SSTEP. Content choice hinges on consideration of the research on students learning and goals such as nature of science (NOS) understanding.

Last year . . . I taught 6th, 7th, and 8th grade. For example, [in] 6th grade you talked about matter and phases and a little bit of chemistry, and then 7th grade you started with plants or whatever and then the second book you’re supposed to talk more in-depth about chemical reactions and stuff. So just from my own stance, I think, “Why not talk about chemical reactions with 7th grade at the same time I’m talking with 6th graders about matter and everything?” So it just made more sense.

And then I found out that in 4th grade, students are learning about electricity and magnetism. And I think in 6th grade [what Teacher C-3 teaches now], I don’t know how much more they can learn about electricity and magnetism because it’s really abstract. So I don’t spend a whole lot of time on that. It’s tough for them to grab. And they just had it. So maybe we’ll ease off of that and spend more time on this other stuff that I know is more important. And then just find ways to touch each concept in a different way. [For example], you can always tie the nature of science into something in a different way. It’s easy to get off onto a tangent on something else.

The ease with which Teacher C-3 modifies his lessons comes from his solid foundation of understanding research-based science teaching. The conviction to question district mandates
and adjust for effective learning requires a firm framework for teaching. The habits promoted at ISU SSTEP equip a teacher to make these choices and create change both in the classroom and teacher’s own behaviors. Teacher C-3 describes the value of considering his transformation as a teacher:

[My RBF] is even changing more now [as] it grows with experience. . . . You have to constantly keep reflecting on what you’re doing to make yourself better. That’s an essential thing right now. It’s a good habit to have.

Teacher C-3 identifies the importance of healthy professional habits. His reflection is active and accurate to his teaching, such as his desire to improve classroom management. This habit of reflection leads to actions for improvement that have varied levels of implementation.

I really want to videotape my classrooms just to watch my interactions with kids that I may not see. It’s hard to be really positive in this environment where kids are so disrespectful a lot of the time. I just want to watch myself respond to kids that are misbehaving. That whole classroom management part—I want to watch and see what I can improve on.

As addressed earlier, Teacher C-3 accurately identifies classroom management as a key ingredient needing attention and improvement. He recognizes helpful strategies that will enhance his practice and reflects on current experiences indicating his effectiveness.

I need to videotape myself more and listen to myself more. I always ask questions. I know I’m asking questions. I need to look at my wait-time more. For the most part, I’m thinking about what questions I am going to ask. I must be doing all right, because I’m not asking a whole lot of questions during the period. And I know I have time to think about other questions so I must be doing a little bit of wait-time in there.

I’ve stuck with not giving answers and that’s driving the kids nuts. Which I love. [laughs] It’s even driving teachers nuts because I’ve done it with teachers now. And I share a room with a teacher and she always talks about what we’re doing in class because she sees some of the labs we do and demonstrations that I do. And I just don’t give her answers and she’s going crazy.
It’s fun just to hear kids [ask], “Aren’t you going to give us the answer?” [I respond], “What do you think?” I wouldn’t give them the answer to that and they’re [say], “Aw, you do that all the time.” And then I hear other teachers telling stories about how [students] ask the teacher a question and the teacher answers them. Or they’ll ask, “Why don’t you go ask [Teacher C-3] about this question?” And [the students] say, “No, we don’t want to because he won’t give us the answers.” So that makes me happy about that. You’re supposed to be doing that. I think it’s good because I’ve done so much questioning that it’s more of a pattern and a learned behavior that I don’t have to really work at it now. So that’s good.

Again, other teachers notice Teacher C-3’s habits. When asked about the sorts of experiences that developed his “learned behaviors,” Teacher C-3 recognizes tasks practiced and promoted in ISU SSTEP.

A lot of it was that initial SATIC coding, making sure what’s a good question and what’s a bad question. Practicing. It’s all about practice. And to really reflect on “Oh yeah, I said this. I could have said that next time.” And I usually try to make up questions before the lesson, and [planning], “This is a good question to ask and this would be a good question to ask at this time.” I usually stick to those. So that helps. And I remember if I start off with a good question it helps keep things rolling and that way.

Teacher C-3’s self-reflection on experiences helps him assess his current performance. He notes the power effective questions have from the very start of a lesson. Classroom taping would further enhance this endeavor for improving practice. Nevertheless, Teacher C-3 is aware of questioning at every stage of the lesson process—planning, teaching, and reflecting. His practice of thoughtfully writing questions before lessons indicates a habit of improving practice. Moreover, Teacher C-3 exhibits other behaviors typifying habits of improving practice:

I’ve gone to all of the professional development that I can. I’ve been to a whole bunch of conferences, really trying to find good material that engages the students. That whole engagement of students has helped me with classroom management and makes it a little easier on me to stay focused. And going back to that RBF, looking at it once in a while and saying, “Oh yeah, these are my goals.” Making sure I know what my goals are and looking at how I’m going to plan a lesson. Making sure I keep the vocab until the end and that kind of stuff. I usually have a mentor so I talk to my
mentor a lot and other science teachers to see what they’re doing in their rooms and seeing what I can be doing and how that can help.

Teacher C-3 shows some reliance on activities to solve his management problems, but he does understand that effective teaching also leads to effective classroom management. He looks to his research-based framework to support his decisions and guide his promotion of goals for students. Teacher C-3’s actions for improving practice include collaboration with colleagues. As Teacher C-3 has alluded to several times, these interactions lead to growth for everyone involved—both he and his colleagues.

**Artifacts**

Artifacts in Teacher C-3’s class include student-designed “black box” tubes with string, part of a decontextualized investigation into nature of science (NOS). Students were explicitly taught NOS concepts as they first observed a tube and then had to design their own models to represent their ideas of the original structure. Teacher C-3 shows interest in his students’ lives by having them complete an information sheet with questions such as “What was your most memorable science experience?” and “What are some topics or subjects that interest you?” Teacher C-3 also promotes parental involvement by giving them a sheet that asks them to describe their child and answer the question, “What do you want your child to get out of my science class this year?” Another artifact is a letter to parents/guardians inviting them to join their children as the science students present over 1,000 hand-made paper cranes to a local hospital in promotion of peace and good health. This project was featured in the city’s newspaper with comments from students and Teacher C-3. Other projects include laboratory investigations, typically in a guided or open-inquiry format. For example, a “Balloon Racer Lab” begins with student groups receiving one balloon, fishing
line, and one straw. Students can add their own materials to create their racer. The initial handout asks students to create a report from their experience that includes their procedure, their design schematic, an original data table, graph, calculations, and a paragraph of results. The lab encourages students’ problem solving, creativity, collaboration, and additional goals. Questions in the initial handout are open-ended and promote further thinking: “How did you measure the speed of your object?” “What would you change about your experiment to make it better?” “What are some things that your group could work on to help your group work more efficiently and effectively?” Other investigative projects include designing and racing solar cars, role-playing changes of state, testing changes on gummy bears, and creating a homemade insulating container that can hold 50 mL of boiling water for 30 minutes with minimal heat loss. Although projects and activities are inquiry-based and feature application, Teacher C-3’s written tests focus primarily on concept memorization and recognition. Tests have an average of 25 questions, 10 of which are multiple choice. The other questions are short answer and feature recall (“What makes up the lithosphere of the earth?”); identification or procedure (balancing and identifying chemical reactions); analysis and NOS-related (“How do we know that the Earth’s inner core is a solid and the outer core is liquid when scientists have never seen anything past the Earth’s crust?”); and application (using data and graphs to locate earthquake epicenters; selecting an element to replace sodium in water softeners and explaining this decision). As addressed in the classroom observation discussion, some topics may be too abstract and developmentally inappropriate for 6th graders, such as writing formulas of compounds between two elements, identifying the type of bond, and describing the valence electrons’ behavior in these bonds.
Summary

**Habits of Understanding:** As seen in his interview responses and artifacts, Teacher C-3 has a high match (H) to the habits of understanding promoted in ISU SSTEP. He uses his student goals to inform his lesson planning. To support his decisions, Teacher C-3 uses research on how people learn, such as connecting concepts to students’ experiences, beginning with concrete activities first, and choosing appropriate curriculum. All of these understandings were key components of ISU SSTEP. Moreover, Teacher C-3 shows these understandings through his negotiation between district standards and his research-based framework. Although Teacher C-3 may teach some concepts that are too abstract for his 6th graders, he does indicate awareness of the need for developmentally appropriate content and strives to meet district expectations while teaching what his student can successfully learn.

**Habits of Action:** Teacher C-3 has a moderately high (MH) match with the habits of action promoted by ISU SSTEP. His choice of content is occasionally inappropriate for the developmental level of his students. However, his strategies are supported by research on how people learn (social interaction, building off of concrete experiences) and foster inquiry, application, and collaboration. Off-task student behaviors hinder the level of engagement and learning. Nevertheless, Teacher C-3’s question and response pattern closely resembles the interactions modeled in ISU SSTEP. Furthermore, his low number of questions and talking are indicative of using few, but effective interactions.

**Habits of Reflection:** Teacher C-3’s actions and interview comments indicate a high match (H) to habits of reflection modeled and taught in ISU SSTEP. He frequently revisits his research-based framework (RBF) paper. He also reflects on his growth as a teacher since graduating from ISU SSTEP. Teacher C-3 realizes that his improvement as a teacher does
not arrive through experience only, but also through reflection, practice, collaboration, and conscious effort.

**Habits of Improving Practice:** Teacher C-3 recognizes several actions he can take for improvement. While he admits he needs to audio- and videotape himself more frequently, Teacher C-3 does exhibit several behaviors that lead to improvement. These include collaborating with teachers to both share and receive useful knowledge and skills, purposefully writing out questions before lessons to assess and engage student thinking, and frequently attending state, regional, and national science education conferences. Teacher C-3 also has continued his learning by reading research available on the NSTA listserv. He communicates with the science education professor at ISU SSTEP about his experiences and questions about teaching science. All of these actions indicate a moderately high match (MH) to habits of improving practice promoted by ISU SSTEP.

**Overall Alignment of Habits with ISU SSTEP:** As a second-year teacher working with students of the youngest age level for his endorsement, Teacher C-3 does exhibit habits that have a moderately high match (MH) to the ISU SSTEP. The level of off-task student behaviors is significant at this time. However, these concerns are normal for a second-year teacher who is still developing smooth classroom management practices. Teacher C-3’s teaching actions may not quite reflect his ideal state, but his understanding and reflection both represent high matches to ISU SSTEP. The challenge is to take actions for improvement, concerning which Teacher C-3 has made significant efforts. In the upcoming years, Teacher C-3’s actions will assuredly have a closer match with ISU SSTEP due to his efforts and practice that typify an ideal teacher from the program.
**Teacher C-4: 2nd Year Teacher (Current Program, MAT)**

**Overview**

During his first year teaching, Teacher C-4 taught integrated science for grades 6-8 at an urban middle school. Now in his second year, Teacher C-4 teaches in a new community and school. He teaches 10th Grade Biology and 11th Grade Principles of Physics at a 9-12 high school, located in a college community/university town of ~25,000 permanent residents. Students are mostly from middle class backgrounds (including some upper/lower) and consist of 10-15% minorities. Class size is 26-30 students. Classroom observations were of the physics course, which featured students of all interests and educational goals.

**Content, Activities, COP Coding**

Deep content understanding, not surface memorization, was an emphasis of Teacher C-4’s teaching (See Figure 26). Lessons featured investigation, individual reflection, classroom discussion, group experimentation and consolidation of ideas. Concepts included core content of Newtonian motion and analysis. In the first observed lesson, students individually completed a “non-graded” pre-quiz and shared their thoughts with each other as a review (a common practice for the class). In this case, they read a description of a moving object (begins at X position, accelerates X m/s every second for X seconds) and had to draw both a position vs. time and a velocity vs. time graph. The class discussion followed, in which students shared how they drew the graph, what “troubles” they had with the information, and more. This in-depth discussion took up most of the class period, with students not arriving at consensus as to the appropriate way to represent this data graphically.
The second set of observations featured forces. The first day was an interactive presentation asking students what kind of forces existed. Teacher C-4 introduced terms “contact” and “long distance” forces and asked students to identify and justify examples of both. Brainstorming was the emphasis in this lesson. Teacher C-4 also used a block of dry ice as a demonstration and had students draw what they think would happen as he applied different forces to it in different directions. He went around the room and moved the dry ice on different tables so students would have closer views of the motion. On the next day of class (third observation), Teacher C-4 posed the issue of how to quantify forces. The students then worked in groups of 3-4 to investigate the relationship between force of gravity (measured in newtons) and the “weight” or mass (measured in grams) of objects. Students
used a spring scale to measure newtons and were told to use a 3-beam balance to measure grams. Most students used the labeled masses (100-g, 25-g, etc.) to get the mass, rather than actually finding the mass. Teacher C-4 brought this issue up by asking students how they could be sure they had the correct amount of grams. Most students did not feel it necessary to measure mass (or what they called “weight”) separately and chose the easier route of using the labeled amount. The students were to draw a graph depicting the relationship of the amount of grams and the amount of newtons (force of gravity) with the objects. Teacher C-4 also asked them to find the equation of the graph (if it was a linear graph). The class ended at this point, with most students having a graph and rounding to a slope of 100 (or some derivative of 10). These lessons correspond to Teacher C-4’s shared rationale for introducing content to students through experiences and discussion, research-based practices promoted by ISU SSTEP.

**Teacher Behaviors and SATIC Pattern**

**Questioning:** Teacher C-4’s initiatory questioning was typically thought-provoking (SATIC 3c) and extended-answer (SATIC 4) questions. As seen in Figure 27, these open-ended questions outnumber simple questions (yes/no, SATIC 3a; short-answer, SATIC 3b) by approximately a two-to-one ratio (36:17). Thought-provoking (SATIC 3c) questions accounted for 53% of all of Teacher C-4’s initiatory questions. Examples from classroom observations are “When you hear the word ‘force,’ what do you think of?”, “What were some troubles you were having with this problem?”, and “Predict the path the dry ice will move.” In the case of the latter question, students had to consider the combination of forces acting on the dry ice and determine the resulting motion. These questions engaged the students in thinking about ideas as opposed to memorizing vocabulary. The questions also assisted
Teacher C-4’s ability to assess students’ understandings. At times, Teacher C-4 did make a statement, define a term, or give an instruction (SATIC 1 and 2; typically four to five times per lesson) where he could have instead asked a question to the students to get at the same concept or idea.

![Figure 27: SATIC coding for Teacher C-4](image)

**Responding:** Teacher C-4’s responses to student comments were typically symmetrical and nonjudgmental. He used mostly student-centered responses of asking students to clarify or elaborate (SATIC 11) or using student ideas (SATIC 12). These accounted for 18 out of 30 (60%) of all of his observed responses to students. Examples of these responses include “How did you determine it?” and “What do you mean by . . . ?” Neutrally acknowledging student comments with “okay” or “all right” (SATIC 6; 4 incidents) accounted for an additional 13% of Teacher C-4’s responses. The remaining 27%
of responses included rejecting student comment (SATIC 5; 1 incident); repeating student comments (SATIC 8; 3 incidents); clarifying student comments (SATIC 9; 3 incidents); and answering student question (SATIC 10; 1 incident). Some of these responses short-circuited the lesson by having teacher input rather than drawing out student ideas. These occasions, however, were infrequent and not typical of Teacher C-4’s classroom interactions.

**Non-verbal Behaviors:** Teacher C-4 gave many more non-verbal than verbal responses to student comments. Typically, he silently smiled, raised his eyebrows, counted on his fingers, and nodded after asking questions and listening to students’ ideas. Teacher C-4 used inappropriate wait-time only twice in the three observed lessons. Both instances occurred during the first observation, when Teacher C-4 used inappropriate wait-time II, not waiting 3-4 seconds after a student response before speaking. He did have a total 13 instances of exhibiting annoying mannerisms during the three observations. These were in the form of asking “All right?”, “Okay?” (different than neutral acknowledgement), or quieting his students at the beginning of class by making the “Shhh” sound. Teacher C-4 used his proximity to students to manage behavior and promote engaged learning. His body language was active and always moving up and down the classroom aisles and sides of the room. When he asked for student ideas, he would write down comments without making any judgmental statements. To engage student involvement (if enough time was available), Teacher C-4 could have asked students to come to the board and write their own ideas. Teacher C-4 used multiple sources for displaying information. To vary the location of attention, he moved among a “smart board”/LCD projector combination, to the chalkboard, to the overhead projector during various segments of discussion dispersed through the lesson. This engaged the students by changing their attention from one source to the other.
Perceived Goals for Students

Teacher C-4 listed the following ten goals he currently seeks to promote in his classroom, four of which he feels he gives the most emphasis:

a) *Students will develop a deep understanding of science concepts (#11)
b) *Students will develop an accurate understanding of the nature of science (#3)
c) *Students will communicate their ideas effectively (#5)
d) Students will work well independently and in groups (#5)
e) Students will critically and logically make decisions (#2, #8)
f) Students will develop investigations to answer questions (#6, #10)
g) Students will use a variety of methods to analyze data (#4, #8)
h) Students will develop an appreciation for science and understand how science affects them, their culture, and our world (#9)
i) *Students will engage meaningfully in science
j) Students will accurately assess themselves and others (#8)

Teacher C-4 gave a student goals questionnaire to all of his classes (120 students). Interestingly, Teacher C-4’s student goals questionnaires had the lowest overall average ratings compared to all other teachers in the study. This may be due to student resistance and institutional constraint, as discussed in the Interview section. As seen in Figure 28, the only goal that had an average ranking higher than 4-“much emphasis” was Goal #2: Students will use critical thinking skills (mean = 4.08, SD = .922). The two goals with the lowest average rankings are Goal #6: Students will actively participate in working towards solutions to local, national, and global problems (mean = 2.98, SD = 1.346) and Goal #12: Students will demonstrate an awareness of the importance of science in many careers (mean = 3.28, SD = 1.154). This is notable because these lower relative rankings are consistent with student responses in other teachers’ questionnaires.
Both skills and understandings are promoted and developed in Teacher C-4’s classroom. Goals that were observed to be extensively promoted were critical thinking (#2), problem solving (#4), deep content understanding (#11), nature of science (#3), creativity and curiosity (#7), self-confidence (#1), communication and cooperative skills (#5). The last goal could have been promoted even further through engagement with all students in the classroom. However Teacher C-4 did check for contributions by moving around the classroom with a checklist for participation at least once a week. Nature of science concepts were addressed through an inquiry approach, consensus-reaching, investigative knowledge-building, and critical thinking. In his biology class, Teacher C-4 used short stories to explicitly address historical, personal, and social aspects of science. Content was deeply investigated by the students, as opposed to a hurried smattering of terms.
Interview

Teacher C-4 has faced student resistance to his research-based teaching and promotion of goals, which will be discussed below. Despite this resistance, Teacher C-4 shares his rationale for having goals for his students.

You always have [goals] in mind so you always know what direction to go; you always kind of know what do to. When people ask you, you can go back to those because people are always asking, “Why are we doing this?” [I answer,] “Because I don’t only care about the content. I care about this and this and this and this.” It’s good that [students] know that you have other goals for them. Even though sometimes they don’t care. [laughs]

Teacher C-4 lists goals as his primary influence when planning how to teach a science lesson. He also gives practical consideration to the resources available and how he can use these to promote his goals.

[I think about my] goals for students. What I want them to learn. How much time I have. How much time I have in each lesson. Resources I have. The types of things we have sitting around. I always try to do the most, the thing that’s going to promote the most goals, but sometimes that’s not always possible because of resources and things. But that’s what I shoot for. Whatever’s going to be promoting the most number of goals, I think that’s important to do because then you’re being effective.

Teacher C-4 reflects on his interactions with students and how these impact his effectiveness. Such reflections echo habits promoted by ISU SSTEP. Teacher C-4 considers the specific behaviors he wants to use to promote his goals and help students learn.

It depends on where we’re at. If we’re at the beginning, I’m pretty open, trying to explore things and getting [students] to think. Asking them questions, trying to tie things back to what they’ve learned before. And trying to introduce this next part that we’re doing. Trying to give them some kind of situation where [students] hopefully have some kind of need to know what we’re about to learn. . . . You always use some things like wait time. I’m always trying to get them to answer questions that take some thinking.

These interactions with students are not dogmatic or procedural. Teacher C-4 elaborates on the importance of choosing appropriate interactions based on the classroom context. He
speaks to the negotiation of addressing students’ preferences and still meeting his goals. In doing so, Teacher C-4 reveals the complex decision-making required in his professional practice.

[If] there’s a test the next day, [my teaching] changes a little bit even though sometimes it probably shouldn’t. I think it does just out of necessity. Just out of necessity of the students. They start to freak out, and a lot of times I say, “It doesn’t matter. You’ve got to go find this [information] out on your own.” And they have to go find it. But sometimes when it gets down to crunch time, if they come in for extra help or something, if it’s one-on-one and they ask, sometimes I think in my head, “Well, am I really going to make them go find this? And take a half-hour and then come back and see me again?”

And I’ve made these decisions in my head. Maybe it’s not so critical that [students] go find this miniscule piece of information. But usually during the class time, like all the weeks, it’s I make them think. And they hate it, a lot of them. They’re not used to that. They’re used to just getting everything given to them. And really they don’t understand how to find the information. So that’s a bad thing. [laughs]

Teacher C-4’s students oppose his teaching toward the goals he has for them. Nevertheless, he reaffirms his rationale for instructional choices fostering students’ critical thinking and ability to use resources.

If they don’t even know how to find [information], then I really shouldn’t be telling them. They really should be trying to go find it. And once they understand that they can go find the information, then it doesn’t matter if I give them the information, because I know they could have found it on their own. If I see a need that they need to know, if they need to learn how to find information, that’s one of my goals with these particular students. . . . It just depends on the situation—how direct I am with information and whatnot.

Again, Teacher C-4’s decisions in planning and teaching depend on his goals for students and the specific context, including students’ current understandings. Teacher C-4 refers to the situation as considering “two levels” of teaching.
Regardless of the particular situation, Teacher C-4 is careful to choose behaviors that constantly promote his goals. He notes how his classroom interactions may seem peculiar in some students’ eyes.

I’m always using humor and trying to be real energetic. [Students] like to poke fun at my faces sometimes I make and my actions. But I think that’s all good. I think that means that they’re at least engaged a little bit. And I think it does get them engaged. I noticed the days when I really am just out there, kind of getting crazy, running around and really almost acting, it seems like some of the information that we’re talking about and discussing, they seem to buy in a lot more.

Teacher C-4 reflects on how his of non-verbal behaviors have a critical role in helping engage students in learning.

In addition to his classroom interactions, Teacher C-4 reflects on the role of planning and selecting appropriate activities. He seeks to improve on his ability to connect these projects within the course sequence. Beyond science curriculum goals, Teacher C-4 wants to help students develop their skills and understandings about the learning process itself.

I do a pretty good job of tying back to what we’ve done before. But I think tying things lesson to lesson, exactly how we’re moving along. . . . In the beginning of the year, these kids have a lot of misconceptions about what school is and about what learning is. They got them from school and all their vast history with learning. And I think just developing some things that help them see when they’ve learned something, what are they doing here, and really why the things that we’re doing in my class, why they’re working in helping them learn. That’s key.

As Teacher C-4 discusses these goals for his both his students and his own professional practice, he describes strategies to meet this desired state. He uses his past experiences as a first year teacher and engineering student to inform his tactics for improvement.

Last year I noticed this, I really want [students] to understand when they have learned something. In electrical engineering, we always had these milestones. Like in the beginning of the year [these milestones] are all posted and you look at them and [the instructors say], “You have to be able to do these things. And when you can do these things you have to show [it]. You have to build the circuit or whatever and demonstrate to the teacher that you can do these things.” At the beginning you look
at these [expectations] and you think, “Oh my gosh, no way. I have no idea how to do any of this stuff.” And then as the year goes on, you learn things. You learn bits and you have to put them together and it’s not like [the teacher] tells you how to do them all. You have to figure it out, put together the things you’ve learned.

This desired state of teaching aligns with Teacher C-4’s goals for students to learn more than science content. Teacher C-4 also acknowledges that this type of instruction requires preparation and effort. He articulates his plans of action.

I really want to do something like that, where I set up some milestones at the beginning. I’m just like, “Hey, you get graded for these on your final, through the semester, through the whole year. . . . You have to be able to put information together to be able to solve these things. And then you have to explain it to the teacher and demonstrate it and all these things.” Somehow do something where [students] can actually say, “Yes, I can do these things now and I couldn’t before. So I must have learned something.”

Teacher C-4 explains how these strategies align with his goals as well as address students’ resistance to engaged learning. He continues to reflect on his teaching experiences.

Sometimes as kids go on, they don’t realize that they’re learning things. I think that a lot of them, they take the test and [think], “Oh, I can forget all this stuff.” They flat-out tell you, “I’m just learning this for the test. I don’t care if I ever remember it again.” All the emphasis [in school] has been put on the grade and the test. So I really want to change my whole grading system. Last year I had a pretty good one. But I changed it a little bit this year to fit in line with a few other things. And I don’t think it’s as good as what I had last year. I think it put more emphasis on it. And I think that the kids sometimes lose sight of even what your grading is.

Teacher C-4 supports his decisions with actual conversations with students.

[W]e were having a discussion in one class where [students shared], “Yeah, the emphasis is on grades. Or it is on points. So that’s what the emphasis is going to be on, not on participating. If we don’t get any points for that, I’m not going to put any emphasis on that.” So you’ve got to put emphasis on what [students] value and somehow, it’s bad, but you’ve got to start giving points for the things that you want to value. It’s kind of a weird thing, but I think I’m going to start.
Teacher C-4 negotiates between his expectations and ways to encourage students to meet them. Although he would prefer not to involve grading for participation, he sees it as a means to promote his goals, or at least overcome initial student resistance.

In addition to having a plan for the future, Teacher C-4 also works to enhance his present teaching. Teacher C-4 describes how he uses his current classroom actions to promote these same expectations of interaction and engaged discussion.

I have started [grading participation] with my white-boarding sessions. [I tell students,] “Hey, I value your time when you’re in these. So I’m going to randomly [grade] it throughout the year. I tell them, “I’m going to grade you on how well you’re participating with your group and I’m just going to stand around and look around and give you a number one through ten. . . . How well are you participating? Are you asking questions? Are you writing on the whiteboard? What are you doing?” And that seemed to work pretty well to get them to do the things that I wanted them to do.

Despite using these strategies, Teacher C-4 still faces student resistance. He shares an example exchange he has used with classes to address these issues.

[Students] sometimes have a problem doing the things I want them to do. They don’t see the value in it. [They ask,] “What are we doing this for?” “What are we doing this whiteboarding for?” And some of them say, “Aw, this doesn’t work.” And I would give them analogies. A lot of them liked analogies. [I say,] “If you had a lawnmower, you’re sitting there complaining, ‘Aw, my lawnmower doesn’t work. It doesn’t cut my grass.’ It doesn’t work.’ Well, look at the situation. You didn’t put gas in it. You didn’t turn it on. You didn’t run it around on your lawn. Of course it’s not going to cut your grass.” They all start laughing [and say,] “Oh, I see.” I say, “You’ve got to try. If you don’t do this, if you don’t ask questions, if you don’t think about this stuff, if you just draw some pictures on the whiteboard, and while we’re whiteboarding, you just sit around and daze off the side, then of course it’s not going to work. Because you didn’t do anything. That is how it works.”

As Teacher C-4 describes these experiences with student resistance, he again looks ahead to future plans and growth from the past.

[I’t]s definitely going to be a process with some of these kids. And just me in general explaining and introducing it to them. I think that I definitely need to approve on that next year. Introducing all my techniques and why I do them and maybe setting up
some things where they see, “Whoa, hey, this did help me do something.” But I think I’ve improved since last year on a lot of things. So yeah, I’m definitely thinking stricter [with respect to] going about my expectations.

Nevertheless, Teacher C-4 knows some students will continue to resist. He prepares a response to their challenges.

They know they’re not going to get away with crap. And there are some kids that don’t like that. I expect you to think. I expect you to do these things. It’s not going to be a cakewalk. It’s not going to be you sitting around getting all the answers from me, memorizing them.

Teacher C-4 attributes additional challenges to the influence of other teachers in the building.

The most direct example is Teacher C-4’s team teaching situation.

The class I’ve had the most trouble with [student participation is] this one that I share. [Students] come to me twice a week and they go to another teacher three times a week. . . . The other teacher [and I] do things a lot differently. So yeah, it’s definitely a stretch. But it’s a good learning experience.

Teacher C-4 describes institutional pressure he faces to fall into pace with other teachers in the school building. He attributes his struggles to create open class discussion to the enculturation students receive in their other classrooms. Students do not ask questions or share ideas because they fear appearing stupid in front of their peers. Teacher C-4 explains that his students are used to playing the “game of school.” Students have no accountability and can wait for the teachers to do all of the work. The teacher is viewed as the all-knowing expert in most other classrooms in the building. Teacher C-4 refers to his situation as feeling like an “alien” in the school.

Perhaps because of his experiences with institutional constraint, Teacher C-4 is diligent in reflecting on his decisions and improving his practice.

I’m always reflecting on what I’m doing. Writing things down what I want to do. I started this diary log thing where I started writing stuff down. I haven’t always kept up on it, but I sure would like to. I just try to keep myself organized. I think that’s
pretty big. I wasn’t very organized last year. And now that I’m teaching the same subject for the next couple of years, I’ve got to get myself organized. And I’ve been doing that with some files. I bought some things to help keep myself organized so I can remember what I did and what I want to change. Because I think sometimes, even if you do write it down, do you look at it? I think that’s hard, that’s one of the challenges.

Teacher C-4 explains how these actions help him reflect and improve as a teacher, especially as works through his first few years of his teaching career. His experiences and reflection assist this growth. Evidence and analysis assist his professional decisions.

Year to year what [am I] doing to make it better? To make it different? And I think especially the first couple of years, it’s almost harder but I’m seeing now the whole picture, you know? And really I couldn’t make . . . a lot of decisions without actually going through it once and [making these decisions], because a lot of teachers teach a lot of content really. I wouldn’t feel it was my place without teaching that content and seeing how the kids reacted to it or what troubles they’re having. I don’t think if it would have been okay for me to say, “Nah, I don’t want to teach that. I don’t want to teach this.”

I could look at the standards and say, “Yeah, it says it in here.” But even if it did say it in there, people could come back and say, “[Students] can learn it fine, they do fine.” I want to see for myself, okay? So to actually have that evidence and saying, “You know what? I tried teaching them this last year. And we spent a lot of time—I actually asked [students] questions that got at what they knew and not at what they could memorize—and they had no idea. And [I] use that next year to change things.

I think within the first few years of a subject, the class should go through radical changes. And you find out if the kids are learning things that you thought you could help them learn, and [if they were] really thinking about what’s important and what they have to know to understand something. And then [I consider] what actually understanding is and how long it takes to get there, get a feel for the kids. Because these kids are way different than the kids I had last year.

As illustrated in the above comments, Teacher C-4’s decisions rely not only on experience, but also on thoughtful reflection and application.

Teacher C-4 shares additional actions he takes to improve his understanding of curriculum, resources, and opportunities for learning. Examples are videotaping himself teaching; keeping current with internet links and projects; learning about his school’s
greenhouse facilities; attending an average of three science education conferences a year; and exploring the possibility of attending summer workshops about a “modeling curriculum” physics program. Teacher C-4 notes he is eager to gain more than additional ideas for strategies and activities from this latter resource. He would also like to study the questioning behaviors used by the workshop leaders. Such consideration shows thoughtful examination of resources rather than simple reliance on them. Teacher C-4’s actions indicate habits of reflection and improvement that align with ISU SSTEP. These behaviors assist him in dealing with institutional constraints from colleagues and students. He also grows in his knowledge and repertoire of resources for teaching science.

**Artifacts**

Teacher C-4’s classroom materials include outline sheets that he described in his interview. These handouts describe the various concepts and skills students “should know when all is said and done.” These materials align with his goals of helping students think more about their own learning and development. The materials also match Teacher C-4’s actions for improving practice. Laboratory projects are typically open-ended, requiring students to determine how they will record and organize data. Some do feature step-by-step instructions, although these procedures address safety concerns. Nearly every project encourages student collaboration, communication, and group reflection about experiences, concepts, and application. Labs also connect to real world applications, such as making the fermented cabbage food kimchi and monitoring the change and effect of pH levels over time.

Assessments for physics require students to apply and their understandings of forces and motion, such as analyzing, drawing, and relating graphs (position vs. time, velocity vs. time); describing situations by inferring from data; and comparing systems and subsequent
changes. Physics assessments address students’ conceptual knowledge in addition to mathematical problem solving skills. Example conceptual questions in assessments include “Why do you push harder on the pedals of a bicycle when first starting out than when moving at a constant speed?” and “Only one force acts on an object. Can the object have zero acceleration? Can it have zero velocity? Explain your answers.” Biology assessments typically feature extended answer problems requiring students to read and analyze evidence, experimental procedures, or narratives. A test on cell division, for example, consists of nine open-ended questions such as “Explain two differences between meiosis and mitosis,” “Explain how a scientific theory and a scientific law are different,” and “Explain one of Mendel’s ideas that meiosis helps to further explain.”

Assessment questions emphasize problem solving, critical thinking, and creativity, among other goals such as deep content understanding. For example, students are given the following scenario and instructions: “The fish in an aquarium swim to the top when the light is turned on. Develop a hypothesis to explain this behavior and design an experiment to test the hypothesis.” Assessment questions promote Teacher C-4’s goal for students to have an understanding of the nature of science (NOS). NOS is also explicitly addressed through short stories in which students read, discussed, and answered questions about the historical, social, and human impact on science. For example, biology students read about Gregor Mendel as an example of the role of society and creativity in science.

Summary

Habits of Understanding: Teacher C-4’s interview responses indicate habits of understanding that have a high match (H) to ISU SSTEP. He continually relates his teaching decisions to the goals he has for students. However, Teacher C-4 also acknowledges the
importance of choosing context-specific curriculum and instruction, using an appropriate balance to meet students at their needs.

**Habits of Action:** As observed in classroom lessons and artifact analysis, Teacher C-4 has a high match (H) to the habits of action promoted by ISU SSTEP. Although student responses in the goals questionnaire are slightly lower than other teachers, Teacher C-4 still shows extensive promotion of his various goals for students. This is evidenced through his use of inquiry strategies, cooperative tasks, student interaction and discussion, consensus building, and explicit nature of science instruction.

**Habits of Reflection:** Teacher C-4 is conscious of the contextual nature of teaching and learning. Actions in his previous teaching experience differ from his current position due to different communities, age groups, and classes. Teacher C-4 negotiates through promoting his goals as well as meeting his student needs. He reflects on his current and past experiences with teaching to guide his decisions for the future. This includes an idea of developing new habits to improve his teaching. All of these behaviors indicate a high match (H) to the self-reflective habits promoted by ISU SSTEP.

**Habits of Improving Practice:** Teacher C-4 exhibits a high match (H) to ISU SSTEP with respect to habits of improving practice. He considers specific actions and indicators that will assist his development as a teacher. He also identifies reasons for students’ resistance to his instruction and acts to explicitly address and overcome these barriers. Actions for improvement are numerous and diverse: recording his teaching, attending conferences, written reflection, and more.

**Overall Alignment of Habits with ISU SSTEP:** All of the above result in a high match (H) between Teacher C-4’s overall habits and ISU SSTEP. He still faces struggles in
making appropriate decisions in each context, finding balance between challenging and supporting students, and honing his assessment strategies. Teacher C-4’s transition from one school to the next in his first two years as a teacher has not weakened his teaching. Rather, this experience with two school settings has strengthened Teacher C-4’s understanding and habits of effective instruction.

**Teacher C-5: 1st Year Teacher (Current Program, MAT)**

**Overview**

Teacher C-5, a first-year teacher, teaches 9th Grade General Science in a school building housing only 9th grade students in a growing suburban, middle and upper-middle class community. He teaches the same class subject (9th Grade General Science) at the same school as Teacher F-5. Students in Teacher C-5’s class live in a community that expects excellence and success and academics and athletics. His students were roughly 80% white and 20% minority. Students were typically well-behaved in Teacher C-5’s classroom. Teacher C-5 began class before the bell rings, asking them to get started with their activity or discussion. He also used the entire class period up until the ending bell.

**Content, Activities, COP Coding**

Despite teaching in his first year, Teacher C-5 experienced many successes in the classroom in the form of mostly attentive students, engaged learning, and quality facilities. Teacher C-5 made the most of these resources in designing inquiry-based labs and projects for his students. Lessons observed were an open-inquiry of heating water (first and second observation) and measuring the effects on temperature and a discussion of specific heat (third observation). For the water lab, students worked as partners and designed their own procedures and decided how to record data. They prepared a presentation of their findings on
miniature whiteboards (day 2), used to display and share their ideas. Active investigation of phenomena occurred, but perhaps some disconnect to the fundamental concepts and applications existed. This lack of connection or “sense-making” may be due to Teacher C-5’s inexperience as a teacher, including this being his first time teaching the lesson and using the activity. Teacher C-5 was aware of this issue and expressed his concern to help students arrive at correct ideas but yet avoiding the traditional, ineffective practice of lecturing to students. This disequilibrium was apparent in the third observed lesson, hence the lower COP Capsule rating (See Figure 29). This is where a strategy such as “talk to your partner” or “think-pair-share” may have been effective to keep students engaged and help them share ideas. Although he did implement these group interactions at times, Teacher C-5 did not use these strategies as fluidly as his other behaviors and approaches. He consciously strived to reach a balance of student-centered learning with sufficient teacher guidance. Despite this area for growth and experience, Teacher C-5 used quality planning and implementation to create investigative opportunities using students’ ideas and provide time for both private reflection as well as group consolidation. Furthermore, group consolidation arose out of students’ private reflection. For example, after the water heating investigation, students worked in their lab groups to summarize their findings on a desktop-sized whiteboard. Groups then shared their ideas to the rest of the class by displaying their whiteboards at the front of the room and highlighting their conclusions. Consolidation and reflection of ideas occurred for both inquiry-based investigations observed.
Teacher Behaviors and SATIC Pattern

Questioning: Teacher C-5 displayed a consistent interaction pattern with his students. His use of questions aligned to the ISU SSTEP, which promotes extensive use of thought-provoking (SATIC 3c) and extended-answer (SATIC 4) questions (See Figure 30). These open-ended questions draw out students’ ideas and encourage engaged thinking. These two types of questions constituted 84% of all of Teacher C-5’s initiatory questions (46 total incidents in three observations). The greatest number of yes/no (SATIC 3a) and short-answer (SATIC 3b) questions occurred during the third lesson (7 incidents out of a total of 9). Teacher C-5 also made his only two statements (SATIC 2) during this third observation. These simpler questions and statements arose during the interactive presentation about
specific heat, in which Teacher C-5 made statements asked simple questions to students about the steps to calculate energy problems.

During the lab activities, Teacher C-5 continuously asked questions of the students to keep them engaged in thinking about their experimentation and decisions. Some students, though, indicated discomfort with being engaged as much by a teacher during the lesson. They did not display as much consideration and often gave an “I don’t know” response, to which Teacher C-5 will let the question linger.

![SATIC Codes](image)

**Figure 30: SATIC coding for Teacher C-5**

**Responding:** As seen in Figure 30, Teacher C-5’s typical response pattern included mostly asking students for elaboration (SATIC 11) and using students’ ideas or questions (SATIC 12). Out of the 47 incidents of responding recorded over three observations, 35 of these responses were either asking for elaboration (SATIC 11) or using students’ ideas.
(SATIC 12). This accounts for almost 75% of all responses. A typical response to students was, “Why might . . .” and asking for clarification of a student’s previous comment. As taught and modeled in ISU SSTEP, such responses promote class discussion and helps the teacher assess the students’ current understandings.

Out of the remaining 25% of responses Teacher C-5 gave, 17% (8 incidents) were acknowledging student comments (SATIC 6) by saying “okay” or “all right.” The remaining responses were one incident of repeating a student comment (SATIC 8) and three incidents of answering student questions (SATIC 10). All four of these teacher-centered responses occurred in the third observation, in which Teacher C-5 presented information on specific heat calculations.

As evidenced above, Teacher C-5’s responses were typically symmetrical, asking students to elaborate on their answers and often non-verbal reactions such as simply raising his eyebrows to indicate acknowledgement. Without telling students ideas, Teacher C-5 worked to draw out their ideas and help them make connections to experiences and concepts. Teacher C-5 did struggle with this at times, mostly not including an example or a comparison to help students make a connection. Such pedagogical content knowledge (PCK) issues may be due to Teacher C-5’s first year of teaching and lack of experience from which to readily access such illustrations.

Non-verbal Behaviors: Only one incident of inappropriate wait-time occurred in the three observations Teacher C-5. In the first lesson, Teacher C-5 exhibited inappropriate wait-time II (SATIC 13b) once, asking a student for elaboration immediately after the student finished commenting, rather than waiting 3-4 seconds for the student to add anything else. During observations, Teacher C-5 used a calm voice, yet increased his vocal volume and
tempo as he questioned and responded to students, showing intense interest in their ideas.
The same voice tone occurred whether he was working with the entire class or engaging one-
on-one with a student or pair of students at their lab station. He smiled and used eye contact
throughout the classroom to communicate value and support to each student. He moved
around the room and used proximity with students, standing at the front of the room only
when he needs to write something on the whiteboard. During the observed discussions,
students were encouraged to come to the board and write down ideas. For example, before
beginning their lab investigation of heating water, Teacher C-5 had a volunteer student go to
the whiteboard, where she solicited and listed peers’ ideas for considerations that need to be
made for safety. Teacher C-5 held out his hands to count student comments on his fingers,
encouraging multiple responses.

During lab investigations, Teacher C-5 moved about the students and their lab
stations (at the back of the room), working with groups on an individual basis, while
frequently monitoring students for safety and on-task behavior. In the third observation as
Teacher C-5 led discussion about calculating specific heat, one student chatted with peers at
her desk cluster. This off-task behavior was a minimal distraction to the rest of the class and
visibly impacted only those students sitting at the same desk cluster as this student. Teacher
C-5 appeared hesitant to address this off-task behavior, as he worked to guide the rest of the
class on their engaged discussion. Teacher C-5 was aware of this situation and described it
after the class was over, acknowledging his own growth in learning how to deal with
classroom management issues while not detracting from the rest of the students’ learning.
Perceived Goals for Students

In the on-line questionnaire, Teacher C-5 reported having thirteen goals for students, nine of which are most emphasized:

a) Students will demonstrate a deep and robust understanding of science concepts (#11)
b) Students will exhibit effective communication skills (#5)
c) *Students will demonstrate critical thinking (#2)
d) *Students will work towards solutions to local, national, and global problems (#6)
e) Students will show respect for self and others (#1, #5)
f) *Students will exhibit self-assessment skills and meta-cognition (#8)
g) *Students will demonstrate creativity and inventiveness (#7)
h) *Students will exhibit an appreciation for science (#9)
i) *Students will apply science outside of the science classroom (#6, #12)
j) *Students will practice civic and community responsibility (#6)
k) Students will demonstrate a profound understanding of the interrelationship between science and other subjects (#12)
l) *Students will exhibit problem solving skills (#4)
m) *Students will demonstrate a deep understanding of the history and nature of science (#3)

Teacher C-5 gave his goals questionnaire to 117 students in his 9th grade science classes. Figure 31 shows that the average student response rated every goal higher than having “much emphasis” (4) in the classroom. The two goals having the highest average rating are Goal #7: Students will be creative and curious (mean = 4.38, SD = .879) and Goal #9: Students will convey a positive attitude about science (mean = 4.47, SD = .888). These are consistent with Teacher C-5’s modeled behaviors and interactions with students in the classroom.
Evidence from classroom observations, teacher artifacts, and the teacher interview supports data from these student responses. Teacher C-5 extensively promoted multiple goals in his classroom: a positive attitude about science (#9) and self-confidence (#1) through a warm and caring environment where students are shown and expected to give respect; creativity (#7) and critical thinking (#2) through questions and investigative projects; communication and cooperation (#5) through group projects and class discussions; and a deep understanding of fundamental concepts (11). Science careers (#12) and connections to local, national and global problems were not addressed (#6), as observed in the classes visited. However, Teacher C-5’s use of a community service project (see Artifacts below) does indicate promotion of the latter goal for working toward solutions. Teacher C-5 reminded students of safety by having them share and write on the board different considerations they will need to make when doing their lab investigation.
Interview

For Teacher C-5, his goals are the foundation of his instructional decisions. When asked about their importance, Teacher C-5 elaborates on how student goals inform his own goals as a teacher:

I think it’s because they [student goals] are at the heart of what I want to teach. I want to help these kids become well-rounded people. That’s what I want to do when it comes down to it. Have them reach the goals that they have in their lives. And help them learn a little bit about the natural world along the way. So that’s kind of at the core of it. Some of these goals are critical thinking and problem solving. If I see someone on the street, those are the types of things I want them to have—to be creative, and to be able to communicate effectively. I have a lot of goals, ten to twelve I guess. But they’re all important.

Teacher C-5 lists his student goals by name and uses them to steer his decisions. He reflects on his experiences as a first-year teacher and recognizes the challenges of this first year. Nevertheless, he uses his goals and research-based framework to inform both his decisions and his purpose.

Every time I feel down, I [think], “Well, why am I doing this? That’s because I want these students to be like this.” I just fall back on that every time. Or, “How do I get them to be like that?” And you think, “Well, these are the strategies that I have to use. These are the materials I should be giving them.” Basically [I go] back to the schematic [for research-based decision-making] and to how students learn.

The research foundation Teacher C-5 uses not only supports his practice, but also equips him to articulate the purpose of decisions: “[Y]ou have to make sure that you know what you’re doing and be able to verbalize that. . . . [Y]ou have to defend what you’re doing.”

In addition to using his goals, Teacher C-5 describes how he uses research on how people learn to guide his planning and teaching:

There are a lot of things that I have to consider. Where the students are at right now in terms of biologically, developmentally. That’s something I consider. Is [the content] going to be too abstract for them or not? And if it is, can I give them something concrete first that will help them get there. Or are they just not ready for
it? Something like that. How they learn, that’s a chunk of it. And then giving them those prior experiences is really valuable for them to be able to build on that understanding through me asking questions as well as them thinking about it. I also think about ways that I can get them talking to each other without getting too distracted. . . . But that’s social interaction and they learn. That’s just amazing to watch them do that. They all understand it. Think about it this way, their language is much closer related than mine is to them, even though I’m only ten years older than them. But I went to a different school and have different situations in life. When they talk to each other it’s different and it’s good.

Teacher C-5’s explanation of why strategies like group interactions work indicate a firm understanding of learning theories, a habit of understanding promoted by ISU SSTEP. Despite having reasons for promoted cooperative learning, Teacher C-5 still faces resistance in the classroom.

I’ve noticed that [the students] still want an answer from me, even though the students can say it better or may know more than I do about the subject. They still want the answer from me even though I’ve resisted just giving them the answers. [That’s] something I expected they’d get used to over time. And maybe they will or maybe I’ll get better at it. But that’s something I was surprised by, they still want that. And I guess to some extent I do too sometimes want answers.

Nevertheless, Teacher C-5 abides by his research-based framework for teaching science. He continues to reflect on his understanding and actions in the classroom. When asked about his interactions with students, Teacher C-5 immediately refers to his questioning and responding patterns:

“They’re typically open-ended questions. I actually was reviewed last week. And [the supervisors] say, “Wow, you have a lot of open-ended questions. And they range in level.” So what they were essentially talking about was [SATIC] 3cs and 4s and I guess 3bs. I’ve recorded and listened to it. Unfortunately, I’ve noticed some “y’knows” sneaking in there a little bit, so that’s something I’ve been trying to work on. . . . But I’d say [I use] mostly open-ended questions and really just thought-provoking questions. I really just try to get [the students] to think, “Well, yeah this happens. But why does it happen? How can we account for that?” And it’s funny because some of the students say, “You always ask those questions.” They will make fun of me. They’ll say, “How do you account for that? How does this happen? Why does this work like it does?” And I say, “That’s excellent. If that’s making fun of me for how I’m asking questions, that’s awesome. That’s what I want.”
Both Teacher C-5’s students and supervisors recognize a significant pattern of behavior in his questions and responses to students. Furthermore, Teacher C-5 is the first to acknowledge these patterns and provide reasons for his behaviors. This rationale supports his decisions in the face of resistance by students.

Teacher C-5 is not satisfied, however, with his current classroom teaching. When asked how he would change his interaction patterns, Teacher C-5 describes several aspects he wants to address:

With my questions specifically, what I would try to do is scaffold them a little more. Still use open-ended questions, but get [students] thinking about something. And then build up to the bigger question. I think sometimes I ask the bigger question first and they get confused. And then I backtrack. But if I were to ask questions that would get [students] there, get them thinking about things to get to the bigger question, then I think they would be better able to answer it. So that’s something that I think will come with experience . . . and effort. But that’s something I’d personally like to see improved with my interaction patterns in terms of questioning. And . . . getting rid of those [SATIC questions] 3as and trying to make some of those [SATIC] 3bs, 3cs to get [students] thinking. I think there’s nothing wrong with having a 3c question that is a little lower, [one] that isn’t extremely cognitively demanding as long as you’re bringing in the other ones afterwards. I think not everything has to be the [highest] level of thinking. I want to kind of build toward that also with questions.

But also interaction patterns, I’d like to see more positive non-verbals. After three or four times it’s hard to be “Hey!”, be really positive and smile like this is an answer I’ve never heard before even though I’ve heard it fifty times. I think that’s something I’d like to work with as well, trying to show more of those positive non-verbals. And I noticed today that when I change my voice, I was really excited and into it, [students] were really excited and into it more. I’ve read the research, but just doing it and seeing how it works, how it affects the actual kids in real life, that really is something that really makes it stick in my mind.
Each of these areas—questions, scaffolding, non-verbal behaviors, contextual decisions—are a part of the central core of effective teaching promoted by ISU SSTEP. More than giving mere recital, Teacher C-5 explains the reasons behind these decisions and target behaviors.

More than having mere aspirations, Teacher C-5 also describes several actions he takes to improve his teaching practice.

I haven’t done it as much as I’d like, but I have recorded [myself teaching]. I’ve audio taped a number of times and I’ve videotaped just once. But that’s something that I think I’d like to do more of. I feel like, unfortunately, I’m just trying to stay above water right now. Just kind of get used to everything. I feel kind of bad about that. But at the same time, I think that’s just the troubles of a first year teacher. So I think I really want to improve.

I was reading this article the other day. . . . I read it when I was in graduate school. . . . And I read it again. And wow, that thing spoke some truth. I just realized that things aren’t as clear as they were when I was in [graduate] school about decisions that I make. I make so many decisions in such a short amount of time. It’s just a lot coming at me at once. Where I think in graduate school, it was a little more, one at a time. The article was saying that. And I think that’s a big struggle that I’m just getting used to . . . having to make all of these decisions at once. And teaching is complex. Having to make all of these decisions at once and still making ones that are meeting my goals. All the time. Not all the time but as much as possible.

About the participation, that’s something I would really like to learn more about. Like why that is that [not calling on specific students] is effective. I’ve looked for research on that. And I’ve found some. But there’s also a lot of research about calling on students. So that’s something I’d like to learn more about.

Teacher C-5 shows action toward learning and growing in understanding beyond topics learned through his ISU SSTEP experience. While Teacher C-5 admits he wants to do more to improve, he also acknowledges his current trials of surviving his first year as a teacher. In addition to the difficulties of doing anything for the first time, Teacher C-5’s experiences also face challenges through institutional constraint. He describes actions he has taken to avoid succumbing to these barriers.
There’s a lot of pressure to be traditional and stuff like that. The article was talking about that. You kind of lose some idealism from what you had. And that’s disappointing because I certainly don’t want to. So I’ve done a lot of things to keep that, calling people, going to meetings, participating in this research. That’s been very helpful.

When asked about the pressures to be traditional, Teacher C-5 describes multiple sources. He first elaborates more on his classroom experiences with students, retelling their reactions when he gave them a more traditional structured worksheet for outlining notes.

They liked this one much better [than the open-ended handouts Teacher C-5 typically gives]. And I asked them why. And some of them just said, “We finally know what you want.” And stuff like that. Other people said it was easier. . . . Students . . . want something easier. They don’t want to think all the time. And I understand that. But it’s hard because at the same time they struggle and I don’t know [how much] I should help them. It’s hard for me to judge that right now. When I should stop pushing and let them relax a little bit, and when I should keep pushing. That’s something that’s difficult for me to figure out.

Teacher C-5 struggles with finding the balance for appropriate guidance. The students’ resistance to inquiry-based instruction adds to this challenge. Teacher C-5 reflects on this when discussing the experience with the traditional worksheet as well as daily interactions.

[This worksheet] was still good enough to give to them. But at the same time, it was a little more structured than normal and they ate it up. They loved it. [laughs] So I get pressure from them to some extent. And then just little comments, like, “Hey, do you have our 3-page papers that we each wrote done? Graded yet?” [I want to respond.] “Um, no kids. I can’t just throw those in the machine like your other teachers can.” [laughs] I never say that to them. But [it takes time] to give them constructive feedback and really assess their stuff. They want it back faster than they want the comments. So [there’s] pressure from students some.

Other parties exhibit institutional constraint. Teacher C-5 discusses pressure from the community and school to conform to their expectations.

Parents haven’t been too bad overall, really. In my department here, [they convey], “You will give them the semester test that we all give.” And that type of pressure. It’s not that explicit, but it’s certainly everywhere implicitly. And I’ve been observed by my administrators. They were talking about participation in my class. And I agree it needs to be better. But I don’t force [students] to participate. I call on people that
raise their hand. I’ve tried to move towards just having them say their ideas and wait for other people to talk and then talk. I may not get to [this level] this year with these kids. But I hope in the future that’s the case. But administration sees I’m not calling on students. And I find that to be problematic.

And I was talking to [another former ISU SSTEP graduate] about that also, and he was saying he was running into the same problems with administration thinking you should call on students. We were thinking we want a classroom where students want to participate, not because they have to. So that’s a pressure to be more of a certain way. [My administrators] were also saying, one person said, “You never praise the kids.” And I said, “Yeah, I know.” [My administrators ask,] “But how do they still know I care?” They know I care but I’ve never really praised them. I think that’s a pressure too. It’s different than what they’re used to and they make comments about that.

Teacher C-5’s interactions with fellow teachers from ISU SSTEP show action to reflect and improve. These are teachers in other schools that share experiences and strategies.

Interactions with these long-distance colleagues occur over the phone, email, and even meeting at professional conferences. Teacher C-5 relates his understanding of teacher behaviors to an experience he had at a conference presentation by fellow ISU SSTEP graduates.

When you’re listening to [students’] answers and you’re really listening to them, listening intently, and you are excited about their ideas, and you take them and you use them, they know. I remember, we were at a [science education] conference not too long ago in Omaha, and I was at [two ISU SSTEP graduates’] presentation. And they were talking at the end about what were some of the teacher behaviors [they] used? And one [audience member] said, “Well, you praised after every single one.” And I said, “Well, they never said anything, but their non-verbals said, ‘Thank you for your idea.’” That was really an interesting idea. That was all non-verbals. That wasn’t anything to do with what they said. That was interesting.

Teacher C-5’s actions and insights indicate a strong understanding of the habits promoted by ISU SSTEP. He continues to learn, grow, and find success in his first year of teaching. The understanding Teacher C-5 has of the ISU SSTEP habits prompt him to continue in his efforts despite challenges and alternatives to effective teaching.
[To] go home at 3:30 and not even think about school—that would be awesome! I think about that when I’m grading at midnight. But at the same time, why are we here? It’s back to those goals again. It always comes back to that. . . . I think that’s a big emphasis. If [teachers] get that, everything else seems to fall into place. You always question that. If I do this, how is that going to impact how I want my students to be?

Artifacts

A discussion of Teacher C-5’s classroom artifacts begins with the classroom itself. He promotes student inquiry and effective questioning with a large poster that has the following phrases: “Why? How? What? To what extent?” Teacher C-5 also has several quotations about science, learning, and success hanging around his room and placed in his course syllabus. Examples are “Education is the most powerful weapon which you can use to change the world” (Nelson Mandela) and “The dictionary is the only place where success comes before work” (Vince Lombardi). Students fill out a confidential information sheet at the beginning of the year that includes questions about future goals, family, extracurricular activities, and expectations for the course, teacher, and themselves. Teacher C-5 also extended the original goals questionnaire for his students to include specific questions about his interactions with students, students’ experiences in his class compared to other classes, and what value the students find in learning science.

Teacher C-5’s first written science assessment is a quiz that addresses measurements and conversions as well as several nature of science (NOS) concepts such as technology, basic and applied research; laws and theories; the creative component of science. For example, students are asked to identify statements as basic, applied or technology and then explain why. Statements include, “What effect squirrels have on the population rates of deciduous trees?”, “How to make a golf tee that will guarantee improved driving distance?”,
and “Why are snakes carnivores?” Students have had experience with explicit NOS instruction through readings and activities. A decontextualized example of NOS used by Teacher C-5 includes the “black-box” PVC tube demonstration with investigation about the inside contents and discussion about how this is like and not like science.

Science inquiry is prominent in Teacher C-5’s lessons. For example, in a unit on weather and water, students receive a sample of “dirty water” said to come form the city’s water supply. After observing the sample, students are to work in groups to create a procedure to purify the water, including the justification for each step. Follow-up questions at the end of the activity ask students open-ended questions for further consideration. Examples are, “If you had to purify 500 gallons if this dirty water, how might your procedure be different?” “What are the pros and cons of your techniques?” “What is the value of learning about water quality?”

Teacher C-5 also supports community outreach through a required service project of student groups. As described in his letter to parents, “The rationale behind such a project is that students may come to appreciate the value of civic responsibility while connecting science to the real world.”

The above descriptions exemplify the activities and assessments used by Teacher C-5. He promotes his goals of creativity, critical thinking, problem solving, communication and collaboration, deep content understanding, and more through these materials. Group research projects, presentations, and laboratory investigations are all open-ended and foster engaged learning beyond surface memorization or the “game” of schooling.
Summary

**Habits of Understanding:** An analysis of Teacher C-5’s interview comments, classroom teaching, and artifacts informs the decision that his habits of understanding are a high match (H) with ISU SSTEP. He not only considers his goals for students, but also articulates in depth the role of research on how people learn (concrete to abstract, prior knowledge, developmental appropriateness, social interactions) in his planning and teaching.

**Habits of Action:** Teacher C-5’s classroom behaviors, use of materials, and strategies all indicate a high match (H) to the habits of action promoted by ISU SSTEP. This is supported by the classroom observations, artifact analyses, and goals promoted and perceived by Teacher C-5’s students. As apparent in his interaction pattern with students, his use of materials and activities, and his framework for teaching, Teacher C-5 not only exhibits the understanding, but also the actions taught and modeled in ISU SSTEP.

**Habits of Reflection:** Despite being in the middle of his first year as a teacher, Teacher C-5 already has high expectations for his professional practice. He does recognize the unique difficulties of the first year, but he does not use it as an excuse. On the contrary, Teacher C-5 admits to the challenges of the unknown and accurately identifies the impact of his own efforts, experience, and reflection. Teacher C-5 clearly articulates the traits of his ideal teaching state, including expanding his understanding of research, asking and responding in ways that scaffold from students’ current experiences and understandings, and more consistently exhibiting positive non-verbal behaviors to increase student engagement. This extensive degree of reflection constitutes a high match (H) to the habits promoted by ISU SSTEP.
Habits of Improving Practice: Teacher C-5 also has high expectations for taking action to improve. He is acting on these self-standards, behaviors that are a high match (H) with ISU SSTEP. Still in his first year of teaching, Teacher C-5 is active in numerous ways to improve his teaching. He has a classroom poster with phrases to help his questioning. He audio and videotapes his teaching and seeks students’ feedback through questionnaires. He reads and reviews research on teaching and learning. He attends and presents at science education conferences, communicates with other teaching colleagues from ISU SSTEP, and volunteers to serve on the science curriculum planning committee for his school building.

Overall Alignment of Habits with ISU SSTEP: All of the above summaries lead to a high match (H) between Teacher C-5’s professional habits and the ISU SSTEP. Even though he is teaching in his first year, Teacher C-5 already exhibits the habits of understanding, action, reflection, and improving practice promoted by ISU SSTEP. One might also argue that Teacher C-5’s one year removed from the ISU program affords him stronger ties and memories of the habits he learned there. As a first year teacher, though, Teacher C-5 faces additional challenges of forging into an unknown experience at such an intense, massive level never experience again in the typical teaching career. Regardless of the impact these two aspects have on a first year teacher, Teacher C-5’s habits do indeed highly match ISU SSTEP.

Teacher C-5 does face institutional constraint, as conveyed in his interview and discussions after class. In commenting on why he might leave full-time teaching, Teacher C-5 cites the “politics of school” as one major reason. Still he admits he would switch to another school district before leaving the profession for good. Students from his school and community expect answers from the teacher so they can regurgitate them back on the test for
a grade. Learning through inquiry is not valued. Teacher C-5 cites a pressure to be traditional from students and staff. This comes in the form of spoken and implicit expectations to “lose idealism” as well as comments from students about the longer time required to assess open-ended assessments, or criticism by Teacher C-5’s administrators, claiming “you never praise the kids.” Nevertheless, Teacher C-5 holds steadfastly to his goals and framework for teaching science, as promoted by ISU SSTEP.

**Summary of Matching between Habits of Graduates and ISU SSTEP**

Table 5 displays a compilation of teachers’ matching to the habits promoted, modeled, and advocated in the ISU SSTEP. These ratings are gathered from each graduate’s individual case analysis and explained determination of alignment. The next two main sections present findings and further analysis with respect to the two research questions.

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H = High match; MH = Moderately High match; M = Moderate match; ML = Moderately Low match; L = Low match

**Findings for Research Question 1: Educational Goals for Students**

The first research question addressed education goals for secondary science students that reflect the consensus reached in the science education community, and also framed the
ends that the ISU SSTEP encouraged its graduates to promote in their classrooms. This topic was broken into categories: what student goals teachers self-report as emphasizing, their students’ classroom perceptions of emphasized goals, evidence of student goal promotion from observation and artifact analysis, and comparison to the student goals encouraged by the ISU SSTEP. Findings associated with educational goals for students include:

- **Finding 1:** ISU SSTEP graduates reported having and promoting multiple goals for students in their classrooms.
- **Finding 2:** Students of ISU SSTEP graduates perceived multiple goals being emphasized in their science classrooms.
- **Finding 3:** Graduates of the current ISU SSTEP exhibited promotion of more goals to a greater extent than graduates of the former ISU SSTEP.
- **Finding 4:** Despite having similar student perceptions, graduates of the current ISU SSTEP more accurately identified goals they emphasize in the classroom than those of the former ISU SSTEP.

The following discussion addresses each of these subtopics with supporting evidence, involving comparisons between program graduate groups as well as between the graduates and ISU SSTEP.

**Finding 1: ISU SSTEP graduates reported having and promoting multiple goals for students in their classrooms.**

A recurring theme in both teacher interviews and on-line questionnaire responses was the notion that science students must develop multiple characteristics and skills beyond mere content knowledge. *Table 6* displays a complete listing of teachers’ goals for students. On average, each teacher had eight (8.0) goals for their students. When separated between graduates of the former and current ISU SSTEP, teachers from the current program had almost three more goals than those from the former program. Teachers from the current program had an average of 9.4 goals for students; teachers from the former program had an
average of 6.6 goals. Further elaboration and examination of the teachers’ goals with respect to the ISU SSTEP will occur below in Finding 5.

Table 6: Number of goals teachers report emphasizing in their classrooms

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<th>Teacher</th>
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| Average of Former Program Graduates | 6.6 | Average of Current Program Graduates | 9.4 |

Finding 2: Students of ISU SSTEP graduates perceived multiple goals being emphasized in their science classrooms.

As seen in Figure 32, students in classrooms of both current and former ISU SSTEP graduates report multiple goals in their classes (See Appendix C for a complete list of goals). The total numbers of students completing the goals questionnaires were 336 for the former ISU SSTEP graduates and 441 for current ISU SSTEP graduates. Overall, students of both groups perceive promotion of the same number of goals at approximately the same level of emphasis. For both groups, the average ranking for every goal is at a moderate or higher level of emphasis. In the classrooms of graduates of the former ISU SSTEP, seven goals are perceived to be promoted at a level between “much” (4) and “very much” (5). Five goals are perceived to have between “moderate” (3) and “much” (4) emphasis in former ISU SSTEP graduates’ classrooms. For graduates of the current ISU SSTEP, five goals are perceived to be promoted at a level between “much” (4) and “very much” (5). Seven goals are perceived to have between “moderate” (3) and “much” (4) emphasis. The slightly higher averages for students in former ISU SSTEP graduate’s classrooms may not be due to stronger emphasis,
but rather discrepancies such as students’ attitudes toward the teachers. For example, graduates of the current ISU SSTEP may have higher expectations and thus may receive slightly lower ratings due to student resentment. Conversely, students in the classrooms of a former ISU SSTEP graduate may be more favorable toward their teacher if they face fewer challenges. Students may give higher ratings to teachers who are not as demanding. In short, students may not respond to the questionnaire with accurate assessment of goal emphasis, but rather simply complete the questionnaire as a sort of opinion poll or comment card regarding their like or dislike of the classroom and teacher. A more accurate and precise measurement of students’ perception of goal promotion would be required in order for a comparison to other studies such as the work of Goodlad (1983, 1984). Despite potential limits of the present study with respect to particular analysis of these perceived goals, the
data can still be evaluated for detecting trends and generating general impressions of the students’ responses.

As briefly mentioned in the results and summaries of individual teachers, some goals are steadily perceived as having lower emphasis. The average student ratings for both current and former ISU SSTEP graduates show the same three goals with the three lowest perceived emphases: Goal #6, Goal #8, Goal #12 as the lowest, second lowest, and third lowest, respectively (See Figure 32). Goal #6 (apply to local, national, global problems) had the lowest perceived emphasis in 8 of 10 teachers’ classrooms (5 of 5 former; 3 of 5 current). In the other two teachers’ questionnaires, students ranked Goal #6 as the second lowest emphasized goal (Teacher C-1) and, interestingly, the third highest emphasized goal (Teacher C-5). This discrepancy for Teacher C-5’s classroom may be due to his extensive use of service learning projects, such as community cancer fundraisers and pollution clean-up. Goal #8 (set goals, self-evaluate) was in the lowest quartile (the third lowest average or lower) for students’ perceived emphasis in 6 of 10 teachers’ classrooms (3 of 5 former; 3 of 5 current). Goal #12 (science in careers) was in the lowest third (fourth lowest or lower) for students’ perceived emphasis in 8 of 10 teachers’ classrooms (5 of 5 former; 3 of 5 current). Goal #10 (access, use resources) also was near the bottom in terms of emphasis, in the lowest quartile for 5 of 10 teachers’ classrooms (3 of 5 former; 2 of 5 current).

The goals students perceived as being promoted the most were not as dramatically consistent or separate from the other goals. As seen in Figure 32, Goal #9 (positive attitude about science) received the highest rating for both graduates of the current and former ISU SSTEP. Along with Goal #9, Goals #2 (critical thinking), #3 (nature of science), and #7 (creativity and curiosity) made up the top third of highest emphasized goals in both groups of
teachers’ classrooms. Interestingly, students in the classrooms of graduates of the former ISU SSTEP perceived Goal #3 (NOS) as having the second highest emphasis. This is noteworthy since the nature of science (NOS) course at ISU SSTEP was not a required course until the current incarnation. This may be due to graduates of the former ISU SSTEP returning to take a nature of science in their continuing studies or graduate coursework while teaching; for example, Teachers F-1 and F-2 both took this course after they began full-time teaching. A section of NOS readings did appear in the former ISU SSTEP science methods class’s course packet. Former program graduates also typically have taught longer and have had time to work on incorporating NOS in their science courses. Teachers’ individual student questionnaires further expand upon the above group averages. For example, Goal #9 (positive attitude about science) was overwhelmingly perceived as the goal with the highest emphasis, as it had the highest average ranking in 8 of 10 teachers’ classes (4 of 5 former; 4 of 5 current). Furthermore, Goal #9 had the second highest perceived emphasis on the other two teachers’ classrooms (F-3, C-4). No other goals were ranked as consistently high across all teachers’ classrooms. However, other goals that were repeatedly perceived as having an emphasis in the highest quartile were Goals #2 (critical thinking), #3 (NOS), and #7 (creativity and curiosity), as reported on individual teachers’ student questionnaires, hence the high average ratings for these goals.

**Finding 3: Graduates of the current ISU SSTEP exhibited promotion of more goals to a greater extent than graduates of the former ISU SSTEP.**

Although student questionnaires indicated generally uniform and “much” emphasis of several goals, classroom observations and artifact analyses point to a greater emphasis of goals by graduates of the current ISU SSTEP. *Figure 33* designates a greater separation
between the emphasis of goals in classrooms of current and former ISU SSTEP graduates. One reason for the more dynamic differences observed than reported by students is due to the disparity in scales, as noted in Chapter 3. Student questionnaires had a range of 1 to 5 with 5 possible choices. The classroom observation rubric had a range of 0 to 2 with 3 possible choices. Using a student questionnaire with only three choices might create more dramatic differences, as students would have to choose among low, moderate, and extensive emphasis. Even so, student questionnaire data may not be as reliable due to a misunderstanding of some goals, a lack of serious effort in answering the questionnaire on the part of some students, and some students rating teachers based on liking or disliking the course rather than promotion of goals.

![Figure 33: Average observed goal emphasis](image-url)
Nevertheless, classroom observations were supplemented with artifact analyses, which support the finding that current ISU SSTEP graduates not only promoted more goals, but to a greater extent with more explicit instruction. For example, current program graduates typically had more open-ended projects or assessments and fewer traditional textbook publisher worksheets than former program graduates. Despite these differences, a trend still appears in the goal emphasis data. In classroom observations of all teachers, Goal #6 (apply to local, national, global problems) and Goal #12 (science in careers) received notably less emphasis than the remaining ten goals.

**Finding 4:** Despite having similar student perceptions, graduates of the current ISU SSTEP more accurately identified goals they emphasize in the classroom than those of the former ISU SSTEP.

Student questionnaire results notwithstanding, graduates of the current ISU SSTEP have a closer match between the goals they report emphasizing and the goals they are observed promoting in the actual classroom. As addressed in Finding 1, the typical current program graduate reported having three more goals than the typical former program graduate. Furthermore, Finding 3 indicates that current program graduates were also more explicit and purposeful in emphasizing these goals in their choice of strategies, activities, materials, and behaviors in the classroom. Graduates of the current program not only had more goals, they also promoted them more extensively than graduates of the former program. Graduates from the current ISU SSTEP were also more aware of their goal emphasis, as evidenced in interview comments. Current ISU SSTEP graduates typically had more elaborate explanations for the role of goals in their planning and teaching, and identified the connections to specific classroom instruction. For example, Teachers C-1 and C-3 both explained rationales for choosing appropriate content out of the department sequence and
putting more emphasis on the concepts and skills that correspond to their classroom student goals. Teachers from the current program also described their reasons for using inquiry activities and experience-first approaches with respect to not only their goals for students, but also to research on how people learn. They more readily mentioned how these approaches promoted goals for communication, collaboration, citizenship, critical thinking, and identified specific pedagogical decisions to foster this development.

**Summary of Results: Research Question 1**

Graduates from both former and current incarnations of ISU SSTEP reported emphasizing multiple goals in their classrooms. On average, current program graduates reported emphasizing about three more goals than former program graduates. This is consistent with observed classroom practice, in which current ISU SSTEP graduates regularly promoted goals with a much greater emphasis than those from the former program. Students of both groups of graduates perceived multiple goals being promoted in the classroom. According to the student questionnaire responses, no considerable difference of goal emphasis existed between the two groups. These perceptions may be due to the way teachers used the assessment tool or students seeing the questionnaire as merely an appraisal of their sentiments for their teacher. Teachers may have given students the questionnaire and not articulated a request for students to be completely honest in their responses so the teacher could use the information to improve his or her practice. Even so, student questionnaires are consistent with observation of graduates and the ISU SSTEP in regard to the low emphasis of goals for students to actively participate in working towards solutions to local, national, and global problems (#6) and to demonstrate an awareness of the importance of science in many careers (#12). This initial analysis of graduates’ goals leads the transition into a further
analysis of graduates’ alignment to ISU SSTEP with respect to the program’s advocated and self-designated habits of mind.

**Findings for Research Question 2: Habits of ISU SSTEP Graduates**

The second research question focused on the habits of understanding, action, reflection, and improving practice exhibited by former and current ISU SSTEP graduates. Furthermore, the inquiry sought to compare these graduates’ habits to those promoted and modeled in ISU SSTEP. The findings associated with this research question correspond to the habits promoted by ISU SSTEP as well as the institutional constraint graduates experienced to use these habits. Findings related to these considerations are as follows, and include reference to the respective ISU SSTEP habit of mind:

- **Finding 1:** Current ISU SSTEP graduates exhibited higher matches to all of the habits promoted and modeled in ISU SSTEP.
- **Finding 2:** Current ISU SSTEP graduates possessed a more extensive understanding of a research-based framework for teaching science as taught in ISU SSTEP (habits of understanding).
- **Finding 3:** Current ISU SSTEP graduates exhibited teacher behaviors and classroom interactions more consistent with those modeled, promoted and advocated in ISU SSTEP (habits of action).
- **Finding 4:** Current ISU SSTEP graduates planned and taught inquiry-based lessons more consistent with those modeled, promoted, and advocated in ISU SSTEP (habits of action).
- **Finding 5:** Current ISU SSTEP graduates reflected on their teaching to a degree that was more consistent with reflection advocated and promoted in ISU SSTEP (habits of reflection).
- **Finding 6:** Current ISU SSTEP graduates exhibited actions to improve practice at a level more consistent with ISU SSTEP (habits of improving practice).
- **Finding 7:** ISU SSTEP graduates reported facing institutional constraint to implementing the research-based science instruction promoted, modeled, and advocated in ISU SSTEP (habits of understanding, reflection).
- **Finding 8:** Current ISU SSTEP graduates were more successful in dealing with institutional constraints in their teaching experiences (habits of action, improving practice).
Before an examination of findings related to particular habits, the first finding addresses the overall habits exhibited by ISU SSTEP graduates with respect to the program.

**Finding 1: Current ISU SSTEP graduates exhibited higher matches to all of the habits of mind promoted and modeled in ISU SSTEP.**

Evidence for this finding comes from comparison of the case analyses for each teacher. A summary of the findings regarding graduates’ habits matching to ISU SSTEP is displayed in Table 7, with the overall summary highlighted. All five of the current ISU SSTEP graduates had either a high (H) or moderately high (MH) overall match. Of the former ISU SSTEP graduates, only one teacher had a moderately high (MH) match with the program, with the other four having a moderately low (ML) or lower match. With the exception of habits of improving practice, three or more teachers from the current ISU SSTEP exhibited high (H) matches for each category of habits. No teachers from the former ISU SSTEP exhibited a high match with any of the habits categories. The findings below discuss aspects and identifiers associated with particular habits.

**Table 7: Summary of habits matching between graduates and ISU SSTEP, overall highlighted**

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_H = High match; MH = Moderately High match; M = Moderate match; ML = Moderately Low match; L = Low match_
Finding 2: Current ISU SSTEP graduates possessed a more extensive understanding of a research-based framework for teaching science as taught in ISU SSTEP (habits of understanding).

As seen in Table 7, all graduates from the current program had high (H) matches to the habits of understanding promoted by ISU SSTEP. Former program graduates all had low to moderate matches to habits of understanding. A central piece of ISU SSTEP is the research-based framework for decision-making in teaching science, represented by the RBF schematic (Figure 1). Nine out of ten teachers in the study elaborated on the role of goals for students when planning and teaching their science lessons. (Teacher F-5 only addressed his goals when asked directly, never again alluding to goals when discussing his planning or teaching.) All teachers reported having multiple goals for students beyond science content, as discussed in Finding 1 to Research Question 1.

Despite the common consideration of student goals, only those teachers from the current ISU SSTEP showed a deeper understanding of other elements of decision-making necessary for effective instruction. Four current program graduates (C-2, C-3, C-4, C-5) explained how research on learning impacts their decision-making. These teachers described the role social learning theory, constructivist learning theory, and developmental learning theory have in informing their planning and teaching. For example, they mentioned determining appropriate content for the students’ age level; drawing out students’ misconceptions by asking questions and helping students move to correct understandings; and purposefully grouping students together to increase interactions and provide more meaningful learning. No one from the former program explained how learning theories supported their decisions. In some instances, a teacher from the former ISU SSTEP would
mention such items, but merely in passing without explanation. For example, Teacher F-5 used the term “misconceptions,” but did not elaborate on their importance, how he would draw them out, or how he would help students change their ideas.

Teachers from the former program typically did not articulate consideration for writing down explicit questions, examples, illustrations, or challenges in preparation for their lessons. Teachers from the current ISU SSTEP (C-1, C-3, C-4, C-5) did explain how their lesson planning process includes preparing specific questions and examples to engage, assess, and guide students in their learning. In addition to planning purposeful teacher behaviors, current program graduates explained how they plan for lessons by choosing appropriate materials and strategies based on research on learning (i.e. learning theories). The issue of context appeared in some teachers’ understanding. Three teachers from the current program (C-1, C-4, C-5) and one teacher from the former program (F-4) noted that their decisions depend on the context of the classroom and students’ experiences. They do not hold a dogmatic view on learning, but rather use their understandings of goals, learning theories, and corresponding strategies within a suitable classroom context. In other words, they know they will not use open-ended questions or student-centered responses in every situation. The teacher may choose a more immediate intervention in a particular context when he or she detects student frustration, safety concerns, time constraints, or unexpected opportunities for further inquiry. In general, teachers from the current ISU SSTEP exhibited more elaborate and extensive understandings of the elements reflected in the RBF schematic, as advocated by ISU SSTEP.
Finding 3: Current ISU SSTEP graduates exhibited teacher behaviors and classroom interactions more consistent with those modeled, promoted and advocated in ISU SSTEP (habits of action).

As seen in Table 7 above, all current program graduates had a moderately high (MH) or high (H) match to the habits of action promoted and modeled by ISU SSTEP. Graduates of the former program had a moderate (M) or lower (ML, L) match. Evidence for current graduates’ closer alignment to ISU SSTEP exists in the analysis of teachers’ SATIC coded behaviors. Patterns of individual teachers are located in the Teachers Case Analyses. Further evidence is displayed in the tables below, which display the percentages of classroom behaviors for each teacher and the average for the two program groups. Table 8 and Figure 34 display data regarding teachers’ initiatory behaviors. The ISU SSTEP promoted, modeled, and advocated the use of open-ended questions (SATIC 3c, 4) with students. As can be seen in below, teachers from the current ISU SSTEP match more closely with this desired behavior. In fact, current ISU SSTEP graduates are more than three times more likely to ask open-ended questions than graduates of the former ISU SSTEP.

Table 8: Percentage* of initiatory teacher behaviors (SATIC coded)

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Teacher Talking (1, 2)</th>
<th>Simple Questions (3a, 3b)</th>
<th>Open-Ended Questions (3c, 4)</th>
<th>Teacher Talking (1, 2)</th>
<th>Simple Questions (3a, 3b)</th>
<th>Open-Ended Questions (3c, 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-1</td>
<td>39%</td>
<td>52%</td>
<td>9%</td>
<td>C-1</td>
<td>34%</td>
<td>39%</td>
</tr>
<tr>
<td>F-2</td>
<td>34%</td>
<td>48%</td>
<td>18%</td>
<td>C-2</td>
<td>11%</td>
<td>54%</td>
</tr>
<tr>
<td>F-3</td>
<td>38%</td>
<td>46%</td>
<td>16%</td>
<td>C-3</td>
<td>26%</td>
<td>35%</td>
</tr>
<tr>
<td>F-4</td>
<td>24%</td>
<td>55%</td>
<td>22%</td>
<td>C-4</td>
<td>20%</td>
<td>28%</td>
</tr>
<tr>
<td>F-5</td>
<td>40%</td>
<td>57%</td>
<td>3%</td>
<td>C-5</td>
<td>4%</td>
<td>16%</td>
</tr>
<tr>
<td>Avg.</td>
<td>35%</td>
<td>52%</td>
<td>14%</td>
<td>Avg.</td>
<td>19%</td>
<td>34%</td>
</tr>
</tbody>
</table>

*Rounded to nearest whole percent
As seen in Table 9 and Figure 35 below, teachers from the current ISU SSTEP also have a higher match to the responding behaviors promoted, modeled and advocated in ISU SSTEP. Responses emphasized by ISU SSTEP are student-centered (SATIC 11, 12), with an occasional value-neutral acknowledgement of student comments (SATIC 6, e.g. “okay”). Current ISU SSTEP graduates are four times more likely to respond in this manner than former ISU SSTEP graduates. Conversely, former ISU SSTEP graduates typically respond in a teacher-centered way (SATIC 5, 7-10) in three out of every four responses. Current ISU SSTEP graduates, however, respond in this manner only one out of every three times.
Table 9: Percentage* of responding teacher behaviors (SATIC coded)

<table>
<thead>
<tr>
<th></th>
<th>Teacher-Centered (5, 7-10)</th>
<th>Value Neutral (6)</th>
<th>Student-Centered (11, 12)</th>
<th>Teacher-Centered (5, 7-10)</th>
<th>Value Neutral (6)</th>
<th>Student-Centered (11, 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-1</td>
<td>77%</td>
<td>10%</td>
<td>13%</td>
<td>C-1</td>
<td>80%</td>
<td>4%</td>
</tr>
<tr>
<td>F-2</td>
<td>88%</td>
<td>3%</td>
<td>9%</td>
<td>C-2</td>
<td>36%</td>
<td>9%</td>
</tr>
<tr>
<td>F-3</td>
<td>69%</td>
<td>21%</td>
<td>10%</td>
<td>C-3</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>F-4</td>
<td>62%</td>
<td>8%</td>
<td>31%</td>
<td>C-4</td>
<td>27%</td>
<td>13%</td>
</tr>
<tr>
<td>F-5</td>
<td>79%</td>
<td>14%</td>
<td>7%</td>
<td>C-5</td>
<td>9%</td>
<td>17%</td>
</tr>
<tr>
<td>Avg.</td>
<td>75%</td>
<td>11%</td>
<td>14%</td>
<td>Avg.</td>
<td>33%</td>
<td>11%</td>
</tr>
</tbody>
</table>

*Rounded to nearest whole percent

Figure 35: Average percentage of responding teacher behaviors (SATIC coded)

Evidence of current program graduates having a closer match to the habits of action promoted by ISU SSTEP also exists in the observation of teachers’ non-verbal behaviors in the classroom. Observations reported in the individual Teacher Case Analyses show that teachers of the current ISU SSTEP use more frequent behaviors promoted by ISU SSTEP than teachers from the former program. Teachers from the current program, for example,
were observed moving around their classrooms more often and more evenly. Teachers from the former program stayed in the front or center of the room (F-1, F-5) or stayed in a static location during whole class discussions and only moved during group or individual work (F-2, F-3, F-4). All teachers from the current program were observed using eye contact and sharing smiles with students. Teachers from the former program were calm and pleasant (F-2, F-3, F-4) or exhibited tense body language and tired voices dealing with student management issues (F-1, F-5). Teachers from the current program were observed using more energetic and engaging body language, such as counting on fingers (C-1, C-5), nodding (C-1, C-2, C-4), and raising eyebrows (C-2, C-3, C-4, C-5). Teachers of the current program also typically used more humor in their classrooms, whereas humor was absent in some classrooms of former program graduates (F-1, F-3, F-5). Teachers from the current program encouraged students to write ideas on the classroom blackboard (C-1, C-5) or on desktop-sized whiteboards in small groups (C-3, C-4, C-5). With a few exceptions, teachers from the former program typically dominated the classroom blackboard and all written information. Exceptions include a game show-type quiz to review terms (F-1), formal student presentations (F-2), and a student volunteer to hold the other end of a slinky demonstration (F-5). No trends or comparisons were observable with respect to teachers using inappropriate wait-time I and II (SATIC 13a, 13b). Teachers from the former program, though, were more frequently observed calling on students by name to answer questions. This habit was not taught or promoted by ISU SSTEP, which referred to research about the negative impact on overall class participation and discussion caused by calling on students by name.
Finding 4: Current ISU SSTEP graduates planned and taught inquiry-based lessons more consistent with those modeled, promoted, and advocated in ISU SSTEP (habits of action).

This finding is consistent with the higher match of habits of action exhibited by current ISU SSTEP graduates. It aligns to Finding 3 above regarding teacher behaviors. Graduates of the current program had a higher match not only to ISU SSTEP behaviors, but also to the types of lessons, materials, activities, and strategies used in the classroom. This finding also correlates to Findings 3-4 to Research Question 1, as effective goal promotion corresponds with effective science inquiry lessons. Evidence for this present finding comes primarily from artifact analysis and classroom observations of each teacher. Classroom observations included rating lessons using the COP coding scheme. The COP measures lesson design with respect to inquiry-based instruction and the National Science Education Standards (NSES). Figure 36 shows that current ISU SSTEP graduates’ lessons rated higher on all four categories as well as the overall capsule evaluation. Teachers from the current ISU SSTEP program were typically observed teaching more consistently with traits described as “extremely reflective of NSES.” This includes: investigative science; consolidation of ideas and sense-making; planned assessment; learning cycle; utilization of students’ prior knowledge; time for private reflection; developmentally appropriate content; science presented as dynamic, inquiry, conjecture; collaborative interactions; among others. While all five teachers from the current program displayed such student-centered lessons, teachers from the former program (F-1, F-2, F-3, F-5) typically used more traditional top-down instruction in which the teacher dominated (or tried to dominate) the lesson by making all decisions, passing all knowledge through the instructor with little input or critical thought required by the students.
Evidence from classroom artifacts provides further support to this finding. Teachers from the current ISU SSTEP program typically had more activities that were problem-based, required group collaboration, and fostered creativity. Other projects involved direct application to community outreach (C-3, C-5) or simulated authentic problems like pollution (C-4). Four current ISU SSTEP graduates (C-1, C-3, C-4, C-5) included explicit questions and applications of NOS concepts in their assessments. Nature of science appeared in materials of former ISU SSTEP graduates, such as the atomic theory historical short stories used by Teacher F-3 and presentation of information about DNA by Teacher F-2. Two former ISU SSTEP graduates (F-4, F-5) did address some NOS concepts, but may have fostered misconceptions in students due to portraying science as procedural and misusing the
word “hypothesis.” Teachers from the former ISU SSTEP typically used more traditional, cookbook lab activities that required students to follow step-by-step directions. Internet-based assignments such as trivia-hunting “webquests” or downloaded articles with prearranged recall questions were used more frequently by teachers from the former program. Former ISU SSTEP graduates were also more likely to limit student creativity and critical thinking by directing them with “hints,” prepared steps, or rubrics. As taught in ISU SSTEP, such assistance may actually lower student engagement and impedes the promotion of goals such as creativity, problem solving, creativity, and ability to use resources. Written tests for both groups were a combination of textbook and teacher-created pages, although former ISU SSTEP graduates typically had more questions requiring term memorization and recall. Current ISU SSTEP graduates typically used more open-ended, problem-based questions requiring students to analyze information, create solutions, and answer in multiple sentences or sketches. All of this evidence from artifacts and classroom observations supports the finding that current program graduates exhibited a closer alignment to ISU SSTEP with respect to choosing, planning, and teaching lessons.

**Finding 5: Current ISU SSTEP graduates reflected on their teaching to an extent that was more consistent with reflection advocated and promoted in ISU SSTEP (habits of reflection).**

As shown in Table 7, current ISU SSTEP graduates exhibited a consistent match with ISU SSTEP regarding habits of reflection. Except for Teacher C-2 (moderate, M), all teachers from the current program had high (H) matches to ISU SSTEP-promoted habits of reflection. Only one teacher from the former program (F-4, moderately high, MH) had a match higher than low or moderately low. When reflecting on their teaching, former ISU SSTEP graduates were more likely to generalize such as working to have better discussions
or get better. Anecdotal recollections accompanied some of these ambiguous comparisons between a desired state and the current state of teaching. Current ISU SSTEP graduates were more likely to readily identify their questioning pattern (according to the SATIC coding scheme) and articulate what they wanted to improve and how to do so, the latter addressed in Finding 6. For example, these teachers mentioned asking fewer yes/no questions and increasing the number of thought-provoking, open-ended questions. Three teachers from the current ISU SSTEP (C-2, C-4, C-5) also addressed their use of non-verbal expressions and behaviors as being vital to effective teaching; no teacher from the former program addressed this essential aspect taught in ISU SSTEP. Teachers with higher matches to these habits of reflection also had more success in identifying and productively working through institutional constraints, as discussed in Finding 8 below.

**Finding 6:** Current ISU SSTEP graduates exhibited actions to improve practice at a level more consistent with ISU SSTEP (habits of improving practice).

Table 7 shows all teachers from the current ISU SSTEP program having a moderately high (MH) or high (H) match to the habits of improving practice promoted and advocated by ISU SSTEP. In contrast, four of the five former ISU SSTEP graduates exhibited moderately low (ML) or low (L) matches. Evidence from the *Teacher Case Analyses* is indicative of current ISU SSTEP graduates’ possessing a higher match to the habits promoted by ISU SSTEP to improve and work toward a desired state of teaching. All five teachers from the current program report that they attend and present at professional science education conferences. This participation is beyond any required actions for school staff development. In fact, some teachers had to present their rationale for attending conferences to their district offices, take personal days to attend, or find substitutes for school days missed due to
attending conferences. No teacher from the former program reported attending science education conferences. Current ISU SSTEP graduates were more likely to regularly read science, education, and science education journals. Four of the five current program graduates (C-2, C-3, C-4, C-5) reported this habit, as opposed to one from the former program (F-3) and another former graduate (F-5) who reported checking the internet for activity ideas. Teachers from both programs reported collaboration with colleagues for improving instruction. All five current ISU SSTEP cited this habit as one method for improving their practice, as did four from the former program. Teachers of the current program described these collaborations as mutual, whereas some from the former program (F-1, F-3, F-5) mainly identified how they rely on other teachers or principals for advice or ideas. Former ISU SSTEP graduates were also more likely to identify “better activities” as a solution to improving their practice, giving less attention to their own behaviors and decision-making. As addressed in other findings, current ISU SSTEP graduates more typically addressed their teacher behaviors and classroom interactions as key elements of lesson effectiveness, an understanding and action promoted by ISU SSTEP. To that end, all five current program graduates described how they explicitly write specific questions and examples in their lesson plans or on classroom posters to help them improve their questioning and interactions with students. Only one teacher from the former program (F-4) noted how preparing carefully designed lesson plans beforehand helps with improving toward her desired state of teaching. Perhaps ISU SSTEP’s greatest emphasis regarding habits of improving practice is for teachers to video- and audiotape themselves in the classroom. Teachers from the current program reported this behavior more often than teachers from the former program. Still, this action was one of the least common behaviors
for improvement reported, despite its prominence in science teaching methods courses in ISU SSTEP. Of the four current ISU SSTEP graduates who reported taping themselves, two (C-4, C-5) taped themselves in the year of the study, while two (C-1, C-3) said they taped themselves in past years. Two teachers from the former program (F-1, F-4) identified taping as an action to improve their teaching. All of the above behaviors indicate evidence of current ISU SSTEP graduates having a higher match of habits of improving practice promoted and advocated by ISU SSTEP. As with reflection, such habits equip teachers to deal with institutional constraints to their science instruction.

Finding 7: ISU SSTEP graduates reported facing institutional constraint to implementing the research-based science instruction promoted, modeled, and advocated in ISU SSTEP (habits of understanding, reflection).

All teachers in the study reported facing barriers to implementing the type of research-based science instruction taught at ISU SSTEP. Institutional constraint appeared to teachers in various forms and with various levels of intensity. Some barriers were explicit, such as colleagues and administrators telling the teachers to follow the district’s traditional curriculum and have complete uniformity regarding scope and sequence. Parents were another group promoting uniform compliance and traditional practices such as lecturing, PowerPoint slides, cookbook laboratory activities, and textbook-based materials. Arcane pedagogy had greater value than research-based instruction in schools. Staff development practices often conflicted with habits promoted by ISU SSTEP. Colleagues and administrators also did not typically support the decisions and actions ISU SSTEP graduates made to foster science inquiry and promote goals for students.

ISU SSTEP graduates experienced institutional constraint through implicit means as well. Teachers sensed a degree of alienation from many of their colleagues. Students
reacted to ISU SSTEP graduates’ teaching with much resistance. Many ISU SSTEP graduates recognized their students’ opposition as a product of multiple years of traditional schooling. Students grew up in a culture of passive receiving and recall of facts with limited understanding or challenging of ideas. As a result, students assume traditional schooling as true learning and respond to ISU SSTEP graduates’ research-based practices with skepticism and defiance. Students were not familiar with teachers promoting educational goals beyond content memorization. ISU SSTEP graduates experienced student resistance to open-ended inquiry investigations, full class participation in discussions, and collaboration in group settings.

**Finding 8: Current ISU SSTEP graduates were more successful in dealing with institutional constraints in their teaching experiences (habits of action, improving practice).**

Although teachers from both programs faced institutional constraints, graduates of the current ISU SSTEP were more effective in negotiating through such barriers. Evidence of these behaviors exists in classroom observations, artifact analyses, and teacher actions for reflection and improvement. The typical behaviors of former ISU SSTEP graduates facing institutional constraint were either passive resistance in the form of avoidance (F-2) or acquiescence to the pressures of colleagues, administrators, parents, and/or students (F-1, F-4, F-5). Current ISU SSTEP graduates, however, exhibited proactive behaviors to successfully negotiate between institutional expectations and research-based science instruction. Actions include giving required science topics various levels of attention and investigation corresponding to what the teachers understood as most appropriate and meaningful to the students’ learning (C-1, C-3). Such modifications included reorganizing the sequence of curriculum for more successful learning and promotion of goals. Another
habit of current program graduates was perseverance. Teachers explicitly taught, modeled, and advocated behaviors representative of inquiry-based science and multiple goal promotion (C-3, C-4, C-5). In doing so, these teachers educated students and other teachers about not only science, but also learning and education. Students in classrooms of current ISU SSTEP graduates were not always receptive to this type of instruction, but they did exhibit behaviors and attitudes indicating a degree of acceptance and understanding.

**Summary of Results: Research Question 2**

Evidence exists from multiple sources that graduates from the current ISU SSTEP exhibit a much closer alignment to the habits of mind designated, promoted, advocated, and modeled in the program. An overall higher match of these teachers is a result of correspondence to particular categories of habits. Current ISU SSTEP graduates had a higher match to habits of understanding, as they articulated a consideration of not only student goals, but also of research on how people learn; appropriate materials, content, activities, and strategies; and specific teacher behaviors necessary for effective instruction. Current ISU SSTEP graduates had a higher match to habits of action, as they consistently exhibited classroom behaviors (questions, responses, non-verbal) more closely aligned with research on effective instruction. They also planned and implemented lessons consisting of more meaningful learning. Current ISU SSTEP graduates’ habits of reflection were a higher match, including greater precision and accuracy in their descriptions of current and desired teaching. Action plans for improving practice also were a higher match for current ISU SSTEP graduates, as they explicitly identified and exhibited a greater number of behaviors for achieving their desired teaching state. As a result of this higher match to ISU SSTEP,
current program graduates experienced more success when confronted with institutional constraints to their research-based science instruction.
CHAPTER 5: DISCUSSION AND CONCLUSIONS

Teaching is incredibly complex. It involves daily endeavors to prepare, enact, monitor and reflect on multiple aspects of learning and instructing in a dynamic setting (Clough, 2003b; Graves, 2001; Leinhardt & Greeno, 1986; Schwartz, 2005; Watson & Konicek, 1990). Thoughtful decisions must occur not only during preparation, but also during instantaneous, incessant instruction. The latter situation is much more common and often much more important. Each non-trivial choice creates a snowball effect of additional decisions, actions, and consequences.

Teaching teachers, therefore, requires the instructor to possess a twofold level of habits of action, understanding, reflection, and improving practice, as teacher educators must both possess these traits and exhibit the ability to teach them to others. Like science education, teacher education has faced a history of stresses ranging between apathy and scrutiny from all levels of public and media sources (Borrowman, 1956, 1965; Collinson, 2004; Feistritzer, 1984; Lanier & Little, 1986; Sutton, 2004). Ever since its humble beginnings during America’s Industrial Revolution, formal teacher preparation has faced doubts regarding its merit (Harper, 1939; Goodlad, Soder, & Sirotnik, 1990). In the recent “Information Age,” science education has been dissected extensively and found particularly lacking (Brinckerhoff, 1982; Craven and Penick, 2001; Shymansky & Aldridge, 1982; Yager & Penick, 1983). Science teacher education has received greater attention as a result (Windschitl, 2005).

The research reported here is part of a large and ongoing effort by Iowa State University science education faculty and graduate students to study the Iowa State University secondary science teacher education program (ISU SSTEP). This overarching study is being
conducted to determine the effectiveness of the former (2000-2003) and significantly restructured (2003-2006) ISU SSTEP, and does not evaluate nor make judgments on the effectiveness of any individual’s science teaching practice. The intent is to compare the effects of the former and new programs, and determine what the current ISU SSTEP does well and what it does not do so well, and how it can be improved. The portion of that larger study reported here looked closely at five teachers from the former ISU SSTEP and five teachers from the current ISU SSTEP to determine how issues related to their education goals for students, and how their habits of understanding, action, reflection, and taking action for future improvement compared to what the ISU SSTEP sought to promote.

While only ten teachers participated in the study, the breakdown of five each from the former and current ISU SSTEP formats affords further insight into the effects of these two different program structures. Results are limited to the extent three classroom observations represent participants’ practice, although other aspects such as student perceptions, curriculum artifacts, and personal interviews provide further data and insight. Other limitations (discussed in greater detail in Chapter 3) include the unexamined influence of graduates’ fieldwork experiences; individual actions for personal improvement; and their past and present interactions with other colleagues, administrators, and the community. Such dynamic conditions are present in qualitative case studies. Nevertheless, one can derive implications from these findings that correspond with past research and apply to the larger realm of science teacher education.

**Implications**

The following paragraphs discuss recommendations for secondary science teacher education programs that seek to escape the cycle of education mediocrity. Teacher education
institutions can increase their influence and validity, contrary to past graduates’ impressions of their preservice programs (Bureau of Educational Research, 1983; Conant, 1963; Goodlad, 1990c; Lanier & Little, 1986; Lortie, 1975). Findings in this study provide insight for teacher educators who want to produce teachers with a higher match to the goals and habits promoted in their secondary science teacher education programs.

**Abundant Time to Teach and Learn**

In the same way that students need time to develop complete conceptions (Appleton, 1993, 1997; Grouws & Cebulla, 2000; Pintrich et al., 1993), so too do preservice teachers require ample time to hone their understanding and skills. Preservice teachers undergo fundamental conceptual change regarding notions about schooling (Craven & Penick, 2001; Dewey, 1904/1965). Time is a crucial ingredient needed for lasting school innovation (Corbett, Dawson, & Firestone, 1984). Innovation in teacher preparation requires the same element. Compared to graduates from the former ISU SSTEP, graduates of the current multiple-semester format have more than twice the time to cultivate their ideas about learning and teaching. Moreover, these teachers have longer time to practice, monitor, and reflect on their instructional skills. This chronological extension aligns with Craven and Penick’s recommendations for providing students enough time for reflection and communication about their experiences and understandings as well as making stronger connections between theory and practice through multiple interactions with educational personnel (2001).

In their study of teacher professional development, Bainer and Wright (1998) report that meaningful pedagogical change requires a minimum of one year for learning, practice and reflection. What is true for inservice teachers in terms of time is arguably accurate for
preservice teacher’s needs. Preservice teachers need at least a full year of teaching methods preparation (i.e. two semesters or more) in order to become better equipped in understanding and skill aptitude for teaching science. The need for more time is clearly supported in the findings of this study. Graduates of both the former and current ISU SSTEP received instruction addressing the same components of a research-based framework taught by the same instructor. Other features of the two programs were quite similar. What stands out as different is the time (both total amount and how it was spread out over several semesters) in science teaching methods courses and associated field-based experiences. Current program graduates exhibited a much stronger match to the habits of mind (action, understanding, reflection, and improving practice) promoted and modeled in ISU SSTEP. Although both groups cited the importance of goals for students, current program graduates were much more likely to readily elaborate on other key elements of teaching and learning: research on how people learn (learning theories); the role of the teacher’s behaviors such as questioning, responding, wait-time, non-verbals, etc., and the choice of particular content, materials, activities, and strategies. Furthermore, current ISU SSTEP graduates typically had greater emphasis on their student goals, both from a qualitative and quantitative perspective. These teachers were observed promoting more goals to a greater level of development. The multiple-semester experience created teachers with superior alignment to the habits of mind and goals promoted by ISU SSTEP.

A model airplane needs time to for its glue to solidify and strengthen. Similarly, preservice teachers require sufficient time for their understandings and skills to cement. Teachers who pass through a preparation program too quickly will experience pedagogical collapses in their classrooms, much like the model airplane that breaks when played with
before its joints have time to bond. The toy model analogy, however, does not address the need for preservice teachers to repeatedly visit educational concepts and techniques. Unlike a model that sits idly while the glue dries, teachers must experience repeated exposure, discourse, and reflection about curriculum and instruction (Feuerstein, 1980; Meier, 2000; Pogrow, 1988). The current ISU SSTEP program was not simply an elongation of the former format. Rather, it increased the frequency and intensity of interactions and experiences in which preservice teachers learned.

Epistemological and pedagogical understandings and skills are not qualities that teachers can learn “on the job” with any assured success. Past research indicates that classroom teachers with brief time in preparation struggle with some of the most critical elements of effective instruction: teaching methods, student motivation, curriculum development and classroom management (Darling-Hammond, 2001; Feiman-Nemser & Parker, 1990; Grossman, 1989; Lenk, 1989; Mitchell, 1987). The present study supports such conclusions, as teachers from the former ISU SSTEP typically have more years of teaching experience, but do not have as high a match with the habits promoted by the program. If not prepared with sufficient time, teachers will never fully develop the habits of mind and goals promoted by their teacher educators. However, time is not the only ingredient necessary for successful teacher preparation. As Kassem (2005) notes, preservice teachers do not develop habits of mind naturally through the passage of days. Teacher preparation programs that desire their graduates to have a high alignment with the promoted concepts and skills must increase the semesters of teaching methods courses. Although time is an indispensable ingredient, much more is needed in the recipe for successful teacher preparation.
Scholars and educators may never finish their debate over the relative amounts of academic and technical preparation required for future teachers. The deliberation has carried on since the beginning of formal teacher preparation in America (Borrowman, 1956; Harper, 1939; Lanier & Little, 1986). Such discussion has not fostered productive development in teacher education. Instead, teacher preparation curriculum remains stagnant, simple, and insufficient (Goodlad, 1990c). As a result, preservice teachers are mired in a moribund mindset with stunted intellectual engagement and leadership capacities (Quinn, Haggard, & Ford, 2006). Schools become populated with staff of the same malnourished qualities. Ultimately, elementary and secondary students (future citizens) feed and function from the same depraved paradigm.

Both academic and technical advocates feared the dilution of teacher education that attempted to develop the two avenues jointly. Dilapidation appears to be the real result. Education for children and teachers has delineated its purpose to teaching basic skills (Goodlad, 1990c). Even this goal has declined in its efficacy.

Regardless of format, the ISU SSTEP promotes multiple education goals for its preservice teachers and their students. Clarity of mission, general and professional studies, and reflective practice all constitute the program, as advocated by Goodlad (1990c) for any teacher education institution. Such objectives include the modeling and development of habits of understanding regarding teacher decision-making, action, reflection, and taking action for improvement necessary for competent teachers. The research-based framework for this level of decision-making (Clough, 2003b; Clough & Kauffman, 1999) emphasizes both scholarly and professional aptitude. It is beyond the scope of this study (and the purpose of
ISU SSTEP) to demarcate the teacher education curriculum debate. However, the promotion of research-based teacher decision-making in the ISU SSTEP produces graduates who possess both a conceptual understanding and technical proficiency required for effective teaching. Rather than fostering dilution of the two approaches to learning and teaching, the program advances synergy with success neither could achieve alone. Preservice teachers experience the academic with application, the technical with the “truth” of liberal learning, philosophy with functionality. They become professionals with perspective, scholars who serve. Joining these equally important aspects is a momentous endeavor, one in which ISU SSTEP faculty (and students) persist in the science teaching methods courses. Even Goodlad (1990c) notes that “the resources, effort, creativity, and leadership needed to create the necessary productive tension between sound theory and sound practice and the integration of the two are prodigious” (p. 269). Nevertheless, teacher preparation that chooses to remain relevant must address curriculum that is appropriate and meaningful for future teachers. As seen in ISU SSTEP, when given enough time, tending to a research-based framework of teacher decision-making that concentrates on both academic understanding and technical ability will nurture graduates with these habits of mind.

**Modeling of Effective Teaching**

A season’s passing and seeds alone do not yield a bountiful harvest. The planter must also indefatigably commit energy toward cultivation and care. Likewise, the habits of mind and goal emphasis taught in ISU SSTEP do not bloom spontaneously. The teacher educator—not just the teacher education program—is essential for the development of preservice teachers. In other words, departments of curriculum and instruction must effectively address the latter as well as the former. Since teachers tend to teach how they
were taught (Goodlad, 1983, 1984; Lortie, 1975), teacher educators must be especially purposeful in modeling effective instruction. Part of this modeling is increasing the involvement and engagement of students. In the science teaching methods courses, the ISU SSTEP instructor frequently reminds his students he is interested in “education, not indoctrination.” To this end, teacher educators must indeed treat “prospective teachers . . . as persons, as capable of participating intelligently in the determination of their own educational courses” (CTE, 1946/1965, p. 244).

At ISU SSTEP, the science methods instructor chooses strategies and behaviors that promote the educational goals such as critical thinking, creativity, curiosity, deep content understanding, communication, and collaboration. The goals he advocates for his preservice teachers are the same goals he wants these future teachers to emphasize with their students. Participants in this study referred to student goals in their interviews, citing how choice of content, activities, and strategies relied on these goals. Although current ISU SSTEP graduates typically included more considerations for goal promotion such as research on learning (learning theories) and teacher behaviors, all ten teachers were aware of developing understandings, skills, and traits in students beyond basic content or skill acquisition. The promotion of some goals, however, was not as extensive. Two goals with a consistently lower emphasis in ISU SSTEP graduates’ classrooms were for students to actively work toward solutions to local, national and global problems (#6), and demonstrate an awareness of the importance of science in many careers (#12). A comparison of this pattern with ISU SSTEP indicates a level of alignment, as these two goals were typically not emphasized as greatly in the science teaching methods courses. Teacher educators, therefore, need to examine what goals they truly have for preservice teachers. Instead of teaching content for
simple preparation for the next level (Yager & Penick, 1983), instructors must emphasize concepts and characteristics that have greater value in students’ lives. As opposed to perpetuating student passivity (Goodlad, 1983, 1984), teachers must encourage and exemplify creativity, curiosity, collaboration, and problem solving for students of all ages and disciplines, including future teachers. Upon identification of the desired goals, teacher educators must actively model, promote, and advocate these traits through the instruction and curriculum of teaching methods courses.

Teacher educators must indeed “practice what they preach” (Goodlad, 1990c, p. 75). In addition to promoting goals for students, instructors must identify, possess and apply the habits of mind deemed necessary for productive learning and teaching. Teacher educators who clamor for self-reflective, self-monitoring, self-improving teachers must exhibit these habits themselves. When instructors of teaching methods present the practice of audio- and videotaping one’s teaching, they must tape themselves too. When they encourage preservice teachers to attend science teacher conventions, teacher educators must attend and present at these same conferences. The habits of mind promoted, modeled, and advocated in ISU SSTEP—understanding, action, reflection, improving practice—were continually present in the science teaching methods classroom. Not only must teacher educators identify and model effective teaching, they must be explicit about these behaviors and the thinking behind them (Gage, 1972; Kassem, 2005). For example, the methods instructor would deliberately ask students to analyze and evaluate his use of questions, responses, non-verbal behaviors, and choice of strategies and activities. The instructor would also call students’ attention to the decisions he had to make at various instants during the lesson. He would inquire about alternative behaviors (responses, questions, examples, order of lesson) he could have chosen
and the comparable impact on the students’ thinking, the lesson sequence, and content learning. As shared earlier, the following statement appears on the front syllabi pages of the ISU SSTEP science teaching methods courses:

This course is a reflection of education research that applies to the emerging consensus regarding the goals for science education. Whenever you perceive a discrepancy, you are expected to respectfully ask, “What is your rationale for . . . ?”

Teacher educators must be willing to be transparent for their preservice teachers. This transparency provides clarity for future teachers to detect and examine the habits of mind necessary for effective instruction. Shulman (1986b) recognizes the implications of this transparency for teacher educators’ own understandings and skills: “Instructions in [teacher preparation] areas will have to improve dramatically to meet the standards of understanding required for teaching” (p. 13). In addition to developing their own teaching methods and understandings, teacher educators must be prepared to face students who prefer pedagogical content knowledge that, although easily digestible, is ultimately lacking in educational nourishment (Dewey, 1929). Explicit teaching about habits of mind for understanding, action, reflection, and improving practice creates much more instability in preservice teachers seeking the deceiving Siren call of quick answers and fixes (Shulman, 1986b).

Recently, the ISU SSTEP methods instructor has increased the degree to which he explicitly identifies the habits of mind he seeks to develop in his students. Along with this promotion is frequently spoken recognition that teaching is complex and requires conscious effort, reflection, and persistence to develop these habits (Husu, 2002; Kassem, 2005).

**Dealing with Institutional Constraint**

Like other professions, job dissatisfaction is a major agent in teacher attrition (Ingersoll, 2003; Mangrubang, 2005; NSTA, 2000; Weiss, 1999; Yee, 1990). Teacher
discontent is especially problematic in a field not only facing increased shortages (Craven & Penick, 2001; Shymansky & Aldridge, 1982; Windschitl, 2005), but also requiring highly developed understanding and skills (Clough, 2003b, 2003c; Clough & Berg, 2006; Clough & Kauffman, 1999; Graves, 2001; Jansma, 1996; Schwartz, 2005; Watson & Konicek, 1990). In this study, institutional constraint was the primary reason ISU SSTEP graduates gave for their potential decision to leave their teaching positions.

The institutional constraint experienced by ISU SSTEP graduates in their schools is a cause for alarm and action. These science teachers faced barriers in multiple forms: administration, colleagues, parents, students, resource limitations, district and state mandates, time limits, and more. Such constraints are similar to those faced by teachers in other subjects worldwide (Desimone, 2006; Duttweiler, 1988; Fullan, 1991; Kahle & Rogg, 1998; Lovette, Savoie, & Armenta, 1998; McElrath, 1988; Meister, 2000; Miller, 1984; Orrill & Anthony, 2003).

As reported in this study’s findings, current ISU SSTEP graduates typically were more adept at identifying and successfully dealing with institutional constraints to their research-based instruction. They were less likely to abscond or submit to these barriers. Current ISU SSTEP graduates were more willing to implement research-based instruction in their classrooms, described by Cuban (1993) as “unforgiving crucibles for testing ideas” (p. 260). One could identify the entire school building or district as a much larger and hotter baptism of fire. Current program graduates still struggled to succeed through obstructions despite their higher match to the habits and goal promotion of ISU SSTEP.

Teacher educators must explicitly address the issue of institutional constraints future teachers will face. Moreover, preservice teachers must learn how to negotiate through such
barriers and still implement research-based instruction. As discussed elsewhere, increasing
time, modeling appropriate habits and promoting goals, and teaching appropriate scholarly
understandings and professional skills all afford teacher educators a greater degree of impact
on preservice teachers’ teaching. Teacher educators truly prepare their preservice teachers
by readily recognizing the resistance graduates will face from students, colleagues,
administration, and more. Furthermore, preservice teachers must learn strategies to reduce
constraints and cope with the conflict.

Beyond classroom pedagogy, teacher educators can also explicitly model the
connection of theory and practice through their interactions with other university faculty,
schoolteachers and administrators, and students (Craven & Penick, 2001). Unfortunately,
teacher preparation institutes are rife with individualism, isolationism, conservativism, and
pessimism (Conant, 1963; Goodlad, 1990c, 1994; Lanier & Little, 1986; Lortie, 1975; Su,
1986). When constraints appear in their own institutions, teacher educators cannot simply
hide in their offices or homes. Avoidance, acquiescence, and stubborn resistance do not
foster growth for preservice teachers, let alone for the institution itself. Teacher educators
must leave their college offices and shed individualism in the name of promoting collegiality.
They must show examples of communication, cooperation, and negotiation for the
improvement of education as a whole. In fact, conflict must be treated as an opportunity to
model effective collaboration (Glickman, 1993). The opposite, negative approach fosters a
much more dire prognosis. Complaints and resentment among teacher educators only
perpetuate the bitterness and inadequacy graduates feel about their teacher preparation
experiences (Eddy, 1969; Fuchs, 1969; Goodlad, 1990c; Griffin & Hukill, 1983; Little, 1981;
Lortie, 1975; Ryan, 1970). When teachers view their preparation as such, the public will easily question the relevance of formal teacher preparation.

**Recommendations for ISU SSTEP**

Results and analysis from this study inform assessment of ISU SSTEP and future action. Increasing the time (length and depth) of science teaching methods courses creates a higher match in graduates’ habits of mind in teacher decision-making. Additional semesters of such coursework could increase the level of graduates’ alignment to the program. If adding science methods courses is not possible, current courses in general education and science content could increase their alignment to the habits of mind promoted in the science methods courses. The nature of science (NOS) course is an example of such synergy. While the instructor of the science teaching methods and NOS courses is not able to teach every course in the ISU SSTEP program, teachers of these general education and science content courses could work more closely with ISU SSTEP faculty to model similar habits and educational goals.

ISU SSTEP must examine the educational goals it has for its preservice teachers and take action to explicitly model and promote them. In the case of the present study, goals for working toward solutions to local, national, and global problems (#6) and goals for learning the importance of science in many careers (#12) were typically not emphasized in the graduates’ classrooms. These goals were also mostly absent in ISU SSTEP science methods courses. Other goals such as critical thinking (#2), a positive attitude about science (#9), and deep content understanding (#11), among others, were extensively emphasized. These goals typically had extensive emphasis in ISU SSTEP graduates’ classrooms. ISU SSTEP must
determine what goals are truly important and then actively, explicitly promote them, as opposed to listing goals but not acting on them.

Cooperating teachers must also be committed to both the goals and habits advocated by ISU SSTEP. Since student teaching and practicum are so critical to preservice teachers’ development, these fieldwork experiences must align to what is learned in science teaching methods, general methods, and science content coursework.

An additional recommendation for ISU SSTEP is to create a mentor program for recent graduates. Although many districts often assign new teachers to a mentor or partner, such experiences may actually create further institutional constraints. As with finding cooperating teachers for student teachers, ISU SSTEP must also seek out mentor teachers to model, assist, and advocate teacher decision-making for new teachers. If such teachers are not readily available, ISU SSTEP may need to create an inservice program that educates current teachers through promotion of educational goals and development of habits of mind. Another alternative is ISU SSTEP having a post-baccalaureate consortium in which graduates can meet together to discuss and reflect on their teaching experiences with respect to their preservice preparation. An ISU SSTEP faculty member could be present to assist the group meetings. Such seminars may even have potential for graduate coursework.

**Further Study**

This study is part of a much larger project analyzing the ISU SSTEP program and its graduates. The comprehensive study will examine these issues at a wider scope and deeper level, along with other aspects of the program. Regardless of the size of the study, research into teacher preparation and educational reform cannot linger at a piecemeal, surface level. Attention must focus on teachers and teaching (Tyack, 1989) and connections to broader
applications (Cochran-Smith, 2004). With respect to these considerations, possible issues to investigate include the following:

1. How do graduates of the current and former ISU SSTEP format compare when studied at the same level of experience? Teachers in the present study had mixed levels of experience ranging from one to six years. Former program graduates did not necessarily exhibit a higher match to ISU SSTEP or rating with respect to the COP observation coding tool. While this finding may refute any questions about experience giving teachers a disproportionate advantage, it may raise the question of teachers’ habits of mind fading as they chronologically distance themselves from their ISU SSTEP experience. To account for this variable, one could create and examine case studies of each teacher during their third or fifth year of teaching.

2. To what extent do ISU SSTEP graduates’ habits of mind and goal promotion change over the course of several years of teaching? A longitudinal study could examine ISU SSTEP graduates’ degree of matching with the program from year to year. How does experience affect these habits and promoted goals? What factors aid in strengthening the match? What might influence the weakening of each graduate’s alignment with ISU SSTEP (i.e. regression)?

3. As stated numerous times, this present study does not address the issue of student achievement and its relationship to ISU SSTEP or its graduates. Rather, the focus was determining to what extent graduates of the former and current program match the goal promotion and habits of mind modeled and taught in ISU SSTEP. Recent research seeks to determine teacher preparation’s influence on student achievement (McNergney & Imig, 2006). A future study of ISU SSTEP could address this topic.
by analyzing student achievement scores of graduates from the current and former programs.

4. This study also does not analyze the relevance of the habits of mind designated and promoted by ISU SSTEP—understanding, action, reflection, and improving practice. One could investigate the theoretical framework from which to categorize and compare such habits of mind with other literature on the subject and related traits of teaching and learning (Husu, 2002; Martinello & Cook, 1994; Meier, 2002; Sizer, 1992, 2004). Furthermore, research of graduates could include closer examination of the impact these habits or traits have on teacher performance and student learning.

5. Questionnaires completed by students provided data about general trends of all graduates, namely with respect to less emphasis on a handful of goals. However, these questionnaires did not provide precise data available for careful comparison among the graduates of the two programs. Students in this study may have perceived the questionnaires about their relative fondness for a teacher and not a measurement of goal emphasis. How might students’ perceptions of goal promotion be assessed with greater precision and accuracy? Future studies may want to provide a script or proctor to accompany the questionnaire so that students have a common framework from which to share their responses. Moreover, what are additional methods from which researchers can gather students’ honest perceptions of goal promotion in their classrooms? A more accurate and precise measurement of students’ perception of goal promotion would be required in order for a comparison to other studies of goals such as the work of Goodlad (1983, 1984).
6. What influence do colleagues and administrators have on the habits of mind and educational goals of ISU SSTEP graduates? How might school and community culture impact teachers’ understandings and actions?

7. All five graduates of the ISU SSTEP current program completed the MAT graduate certification sequence. How might their habits of mind and education goals compare with teachers who completed the ISU SSTEP current program as undergraduate students?

8. An optional 1-credit hour seminar for future biology teachers was offered for preservice teachers in ISU SSTEP. How might involvement in this program impact graduates’ classroom teaching, promotion of goals, and habits of mind compared to those who did not participate in this course?

9. The habits of mind and educational goals of ISU SSTEP were primarily promoted, modeled, and advocated in the secondary science teaching methods course(s). Graduates of both program formats, however, attended several other science content courses and general education courses (foundations of teaching, multicultural education, education philosophy, educational technology). Windschitl (2005) identifies these preservice components as one critical area for study in science teacher preparation. To what extent do these classes and experiences impact graduates’ habits of mind and educational goals?

10. Windschitl (2005) also inquires about the characteristics and predispositions of individuals before they even enter a preservice teacher education program. How might these understandings, beliefs, backgrounds, and skills impact the performance of preservice teachers during the program and full-time teachers graduated from the
program? One particular trait is the teacher’s personal passion for educating children. Beyond intellectual level or previous experience, each individual ultimately determines the amount of effort he or she will give to teach children and improve their professional practice. What factors contribute to the amount of passion a teacher possesses? How does this impact the teacher’s habits of reflection and improving practice? For example, many teachers in the study identified actions they should take for monitoring and improving their professional practice; however, only a handful actively pursued these actions. ISU SSTEP graduates also experienced barriers to implementing research-based science instruction. How might a teacher’s persistence through institutional constraint relate to his or her personal devotion to educating children? How might a teacher preparation program identify and cultivate these traits in its preservice teachers?
Concluding Remarks

THE ROAD NOT TAKEN

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

by Robert Frost (1916)

Like American education, teacher preparation stands at a crossroads. It can choose to continue following the cycle of mediocrity marked with occasional spurts and stalls. No matter the effort, this route will still get teacher education nowhere but exhaustion or possibly extinction. The other path is certainly less traveled by. It requires a pioneering spirit to overcome the rut and explore the unknown—the possibility of lasting excellence in education. Formal teacher preparation may never return to the exclusive setting of the normal school. That road was taken. Akin to Robert Frost’s traveler, teacher education will
find enlightenment only when it steps forward in a new direction. Make a choice to act. Follow through with decisions. Only then will teacher education make a difference.

Goodlad (1994) notes that curriculum development is notoriously slow in teacher education institutions. Unlike the tortoise, teacher preparation is not steady. This erratic, sluggish pace will not win the race for educating teachers. Now is the time to act.

Teacher educators must take immediate, thoughtful, and purposeful action if they do not wish to be “judged irrelevant” (McNergney & Imig, 2006, p. 1). Curriculum development may involve Byzantine bureaucracy. As with the experiences of schoolteachers, teacher educators can negotiate through such institutional constraints to create positive change. Effective teacher education demands individuals who are serious in their attempts for improvement. Open the office door. Attend, pay attention, and contribute in department meetings. Bypass the latest conference for the nearest classroom. Study insightful epistemology and develop effective pedagogy. Continue learning. Practice what is preached. Be generous of time and spirit. Invest in the economy of time. Add multiple semesters of teaching methods and model appropriate habits and goals. Instill pride and expect excellence of students and self. If educating children is truly valuable, educating teachers must warrant equal—if not greater—merit. Genuine passion requires action. Children deserve the best teachers can offer. Future teachers, in turn, deserve the very best.
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APPENDIX A: LETTER OF CONSENT FOR PARTICIPANTS

Hi XXXXX,

This is Dr. Clough from Iowa State University. I hope this greeting finds you well, and that you have fond memories of the time you spent in my course(s). You might recall that I indicated to each of your science methods classes that we would contact you sometime in the future asking you to participate in a study of the ISU secondary science teacher education program you completed. I understand that not all former students may still be in the teaching profession, but I would like to hear from all former graduates of our program for this important study.

This study is being conducted to determine the effectiveness of the ISU secondary science teacher education program. The study does not evaluate nor make judgments on the effectiveness of any individual's science teaching practice. We wish to determine what the ISU program does well and what it doesn't do so well, and how it can be improved. We want this study of our program to accurately reflect its influence on former students. For that to be the case, we need as many former students as possible to participate, and we need them to be quite honest and candid in their remarks about the program they completed.

If you agree to participate in this important study of our program, you may decide to take part in as many of the following as you wish:

- Complete a survey (This will take approximately 15-30 minutes and can be done on-line or by postage-paid U.S. mail).
- If you are currently teaching or have taught in the past, provide us artifacts of your choosing that illustrate what typically occurred in your classroom (e.g. course syllabus, lesson plans, assignments, and anything else you feel that would help us understand how you teach/taught).
- If you are currently teaching, permit us to observe you teaching three science classes.
- If you are currently teaching, permit us to interview you after each observation to hear your impressions of the teaching session we observed (we expect each interview to last 15-30 minutes).

Teachers who elect to participate in the study will, unfortunately, not be compensated for their time participating in this research. However, future humankind may benefit from this study through the improvement of science teacher preparation programs. If at anytime you feel burdened or uncomfortable in this study, you may withdraw without risk or penalty. There are no risks associated with this study. Pseudonyms will be used so that participants and their schools cannot be identified.

Questions, comments, and any concerns with this study may be directed to:
Dr. Michael Clough, mclough@iastate.edu, (515) 294-1430
Dr. Joanne Olson, jkolson@iastate.edu, (515) 294-3315

Participant’s name (printed) _______________________________________________________
Signature: ______________________________________________________________________ Date: ______________________
### APPENDIX B:
CLASSROOM OBSERVATION CODING TOOLS

(1) – LSC Classroom Observation Protocol (COP)

<table>
<thead>
<tr>
<th>Overall dimension</th>
<th>Specific sub-dimensions/exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design:</strong> Based on Pre-Conference and Lesson Plan</td>
<td>• Purpose and goals</td>
</tr>
<tr>
<td><strong>General Descriptor of Session</strong></td>
<td>• Stressed investigative science</td>
</tr>
<tr>
<td><strong>Category Rating</strong></td>
<td>• Engaged, challenged and used participants' ideas</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>• Utilized interactions and various groupings</td>
</tr>
<tr>
<td>Not at all</td>
<td>• Explored central issue activity</td>
</tr>
<tr>
<td>Extremely reflective</td>
<td>• Consolidated ideas and promoted sense-making</td>
</tr>
<tr>
<td>of NSES</td>
<td>• Planned assessment</td>
</tr>
<tr>
<td><strong>Implementation:</strong> Based on the Classroom observations and Post-Conference (option)</td>
<td>• Demonstrated engage, explore, consolidate, assessment approach</td>
</tr>
<tr>
<td><strong>Category Rating</strong></td>
<td>• Used questioning to challenge ideas, promote inquiry, support sense making</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>• Utilized students' prior knowledge</td>
</tr>
<tr>
<td>Not at all</td>
<td>• Encouraged public discussion of idea</td>
</tr>
<tr>
<td>Extremely reflective</td>
<td>• Provided time for private reflection</td>
</tr>
<tr>
<td>of NSES</td>
<td>• Paced activities and managed classroom</td>
</tr>
<tr>
<td><strong>Science Content:</strong> Science concepts, processes and habits-of-mind identify in pre-conference and classroom observations</td>
<td>• Content was significant and worthwhile</td>
</tr>
<tr>
<td><strong>Category Rating</strong></td>
<td>• Content was age and developmental appropriate</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>• Students were intellectually engaged</td>
</tr>
<tr>
<td>Not at all</td>
<td>• Teacher displayed understanding and confidence</td>
</tr>
<tr>
<td>Extremely reflective</td>
<td>• Science presented as dynamic, inquiry, conjecture</td>
</tr>
<tr>
<td>of NSES</td>
<td>• Connection made to real-world and cross-disciplines</td>
</tr>
<tr>
<td><strong>Classroom Culture:</strong> Judgment of the appreciation of diversity (gender, race/ethnicity, culture), cooperative/collaborative and intellectual climate</td>
<td>• Active participation encouraged and valued</td>
</tr>
<tr>
<td><strong>Category Rating</strong></td>
<td>• Respects students' ideas, questions, contributions</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>• Interactions reflected collaboration</td>
</tr>
<tr>
<td>Not at all</td>
<td>• Encourage students to generate ideas, questions, conjectures and propositions</td>
</tr>
<tr>
<td>Extremely reflective</td>
<td>• Intellectual rigor, constructive criticism,</td>
</tr>
</tbody>
</table>
395

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Rationale:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interfered</td>
<td>Facilitated</td>
<td>with learning</td>
<td>learning of all</td>
<td>challenging ideas and supportive help</td>
<td></td>
</tr>
<tr>
<td>Capsule:*</td>
<td>1: A</td>
<td>B</td>
<td>2:</td>
<td>3: low</td>
<td>solid</td>
<td>high</td>
</tr>
</tbody>
</table>
*Capsule Ratings recoded as described below.

## Descriptions of Capsule Ratings: (HRI, 2006, p. 11)

### Level 1: Ineffective Instruction
There is little or no evidence of student thinking or engagement with important ideas of science. Instruction is unlikely to enhance students’ understanding of the discipline or to develop their capacity to successfully “do” science. Lesson was characterized by either:

- **A: Passive “Learning”** – Instruction is pedantic and uninspiring. Students are passive recipients of information from the teacher or textbook; material is presented in a way that is inaccessible to many of the students. *(Recoded as 1)*
- **B: Activity for Activity’s Sake** – Students are involved in hands-on activities or other individual or group work, but it appears to be activity for activity’s sake. Lesson lacks a clear sense of purpose and/or a clear link to conceptual development. *(Recoded as 2)*

### Level 2: Elements of Effective Instruction *(Recoded as 3)*
Instruction contains some elements of effective practice, but there are substantial problems in the design, implementation, content, and/or appropriateness for many students in the class. For example, the content may lack importance and/or appropriateness; instruction may not successfully address the difficulties that many students are experiencing, etc. Overall, the lesson is quite limited in its likelihood to enhance students’ understanding of the discipline or to develop their capacity to successfully “do” science.

### Level 3: Beginning Stages of Effective Instruction *(Low, Solid, High) *(Recoded as 4, 5, 6)*
Instruction is purposeful and characterized by quite a few elements of effective practice. Students are, at times, engaged in meaningful work, but there are some weaknesses in the design, implementation, or content of instruction. For example, the teacher may short-circuit a planned exploration by telling students what they “should have found;” instruction may not adequately address the needs of a number of students; or the classroom culture may limit the accessibility or effectiveness of the lesson. Overall, the lesson is somewhat limited in its likelihood to enhance students’ understandings of the discipline or to develop their capacity to successfully “do” science.

### Level 4: Accomplished, Effective Instruction *(Recoded as 7)*
Instruction is purposeful and engaging for most students. Students actively participate in meaningful work (e.g. investigations, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and the teacher implements it well, but adaptation of content or pedagogy in response to student needs and interests is limited. Instruction is quite likely to enhance most students’ understanding of the discipline and to develop their capacity to successfully “do” science.

### Level 5: Exemplary Instruction *(Recoded as 8)*
Instruction is purposeful and all students are highly engaged most or all of the time in meaningful work (e.g. investigations, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and artfully implemented, with flexibility and responsiveness to students’ needs and interests. Instruction is highly likely to enhance most students’ understanding of the discipline and to develop their capacity to successfully “do” science.
(2) – Modified SATIC* Coding Sheet

Teacher:             Course:         Date:
Lesson goals:    Lesson objectives:

<table>
<thead>
<tr>
<th>Teacher Behaviors</th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initiatory (talking)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Lectures or gives directions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Makes statement or asks rhetorical question</td>
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<td><strong>Initiatory (questioning)</strong></td>
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<td>3. a) yes/no question</td>
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<td>b) short-answer question</td>
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<td>c) thought-provoking short-answer question</td>
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<td>4. Extended-answer question</td>
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<td><strong>Responding (teacher-centered)</strong></td>
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<td>5. Rejects student comment</td>
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<td>6. Acknowledges student comment</td>
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<td>7. Confirms student comment</td>
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<td>8. Repeats student comment</td>
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<td>9. Clarifies or interprets what student said</td>
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<td>10. Answers student question</td>
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<td><strong>Responding (student-centered)</strong></td>
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<td>11. Asks student to clarify or elaborate</td>
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<td>12. Uses student question or idea</td>
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<td><strong>Non-verbal Behaviors</strong></td>
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<td>13. a) Inappropriate wait-time I</td>
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<td>b) Inappropriate wait-time II</td>
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<td>14. Passive non-verbal behaviors</td>
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<td>15. Annoying mannerisms</td>
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* A teacher behavior assessment devised by Dorothy M. Schlitt and Michael Abraham (modified by Michael P. Clough)
(3) – Classroom Promotion of Student Goals

Teacher: ____________________   Observer: ____________________
School: ____________________   Date: ____________________

Scale:  2 = Extensively promoted  1 = Moderately promoted  0 = Not promoted

___ Convey self-confidence and/or a positive self-image.

___ Use critical thinking skills.

___ Convey an understanding of what science is, what real scientists are like, and how science really works.

___ Identify and/or solve problems effectively.

___ Use communication and/or cooperative skills effectively.

___ Participate in working towards solutions to local, national, and/or global problems.

___ Be creative and/or curious.

___ Set goals and/or self-evaluate.

___ Convey a positive attitude about science.

___ Access, retrieve, and use the existing body of scientific knowledge in the process of investigating phenomena.

___ Demonstrate deep understanding of fundamental science concepts rather than covering many insignificant/isolated facts.

___ Demonstrate an awareness of the importance of science in many careers.
APPENDIX C: CLASSROOM GOALS QUESTIONNAIRE TO SCIENCE STUDENTS OF ISU SSTEP GRADUATES

Based on what you have experienced in this class, for each item below, please consider how much emphasis you feel the instructor/course has placed on that goal. Then circle the number that best reflects that emphasis. If you have any questions, please ask your teacher for help. Thanks!

Very Little      Little    Moderate     Much      Very Much

1. Convey self-confidence and a positive self-image.
   1  2  3  4  5

2. Use critical thinking skills.
   1  2  3  4  5

3. Convey an understanding of the nature of science.
   1  2  3  4  5

4. Identify and solve problems effectively.
   1  2  3  4  5

5. Use communication and cooperative skills effectively.
   1  2  3  4  5

6. Actively participate in working towards solutions to local, national and global problems.
   1  2  3  4  5

7. Be creative and curious.
   1  2  3  4  5

8. Set goals, make decisions, and self-evaluate.
   1  2  3  4  5

9. Convey a positive attitude about science.
   1  2  3  4  5

10. Access, retrieve and use the existing body of scientific knowledge in the process of investigating phenomena.
    1  2  3  4  5

11. Demonstrate deep understanding of science concepts rather than mastery of many insignificant/isolated facts.
    1  2  3  4  5

12. Demonstrate an awareness of the importance of science in many careers.
    1  2  3  4  5
APPENDIX D:
ON-LINE ISU SSTEP GRADUATE QUESTIONNAIRE*
(http://www.hs.iastate.edu/surveys/stegq/)

General Information:

Name:

E-mail address:

Participant identifier code:

Age:

ISU graduation date (semester, year):

Subjects, grade levels, and duration of courses that you currently teach and have previously taught. (e.g. biology, grade-10 for 2 years; physics, grades 11-12 for 1 year):

When did you begin teaching at this school (year)?

At how many other schools have you taught?

If you taught at other schools, please indicate how long you were there and your reason for moving.

How long do you believe you will continue teaching?

Prior to student teaching you completed one or more science education courses at ISU (e.g. science methods course(s), nature of science course, restructuring science activities, and/or advanced pedagogy). How well do you feel the course(s) you took prepared you teach science?

Indicate below how well you feel your science education course(s) prepared you to teach science.

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<th>8</th>
<th>9</th>
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<tbody>
<tr>
<td>not at all</td>
<td>very strongly prepared me</td>
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</table>

The ISU science education program emphasized the development and implementation of a research-based framework for teaching science. How do you use this research based approach, if at all, to inform your teaching?
In your RBF you listed student goals for science education that you felt were important at *that* time. What *now* are your goals for science students? Please place a check next to the goals you feel you most emphasize in your teaching.

Prior to student teaching you completed several *general education* courses at ISU (e.g. foundations of teaching, education technology, educational psychology, and multicultural education). How well do you feel these courses prepared you to tech?

Indicate below how well you feel your general education courses prepared you to teach.

1 2 3 4 5 6 7 8 9 10
not at all very strongly
preparing me

Where did you student teach and who was your cooperating teacher?

Briefly describe your student teaching experience and how it has influenced your teaching.

Indicate below how well you feel student teaching prepared you to teach science.

1 2 3 4 5 6 7 8 9 10
not at all very strongly
preparing me

How well do you feel the ISU secondary teacher education program *as a whole* prepared you to teach science? (this includes your science education, foundations, multicultural, and other licensure courses, as well as student teaching)

Indicate below how well you feel the science education program *as a whole* prepared you to teach science.

1 2 3 4 5 6 7 8 9 10
not at all very strongly
preparing me

What assignments/experiences that you completed in your ISU teacher education program (this includes all your education courses) do you feel most helped you learn to teach effectively?

Please share any additional information that you feel would help us better understand your experience in the ISU teacher education program, especially in terms of your science education experiences, including how you think it can be improved.

*Both teaching and non-teaching graduates completed the survey. Changes in the wording (i.e. “when you taught”) were used for graduates who selected “not currently teaching” at the beginning of the survey. An additional question was given to these graduates:

What were your reasons for leaving the science teaching profession or never teaching?
APPENDIX E: 
SEMI-STRUCTURED INTERVIEW QUESTIONS

Post-Survey Questions (original survey questions in italics):

Q2E: How long do you believe you will continue teaching?
>What sorts of things would drive you away from full-time teaching?

Q3A: Prior to student teaching you completed one or more science education courses at ISU (e.g., science methods course(s), Nature of Science course, restructuring science activities, and/or advanced pedagogy). How well do you feel the course(s) you took prepared you to teach science?
>“Talk at me.” Elaborate as to what specific pieces were beneficial, significant? What did you take away from the courses (NOS, Methods I & II, Restructuring Activities, Advanced Pedagogy)?

Q4: The ISU science education program emphasized the development and implementation of a research based framework for teaching science. How do you use this research based approach, if at all, to inform your science teaching?
>What parts of the RBF?
>How does it NOT inform your teaching?
>To what extent is the Oral Defense helpful/not helpful?
>Let’s say you were to write the RBF paper but not have an Oral Defense. How do you think this would affect how serious, etc., you worked on learning to understand effective teaching?

Q5 (goals listing):
>(Refer to goals they listed as presently promoting) What makes these goals important?

Q6A: Prior to student teaching you completed several general education courses at ISU (e.g., foundations of teaching, education technology, educational psychology, and multicultural education). How well do you feel these courses prepared you to teach?
>Elaborate – What was useful? In detail, what made them useful?
>If not useful, tell me why what wasn’t the case?

Q7B: Briefly describe your student teaching experience and how it has influenced your teaching.
>Abotu the cooperating teacher, what made him/her great?
>If not a good experience with the cooperating teacher, how do you think that affected your growth and learning as a teacher?
Q9A: What assignments/experiences that you completed in your ISU teacher education program (this includes all your education courses) do you feel most helped you learn to teach effectively?
> If need to jog memory – Methods: taping, RBF, OD, Lesson plans;
   NOS: revising lessons

Post-Observation/Teaching Questions:

> What factors go into consideration when planning a lesson? Teaching a lesson?

> What do you think about the way you interact with students?

> How would you change your interaction patterns?

> Being as precise as possible, what are areas you feel you want to improve as a teacher?

> What kinds of things are you doing to get yourself there?

Additional Questions for Interviews and Conversations:

- Tell me about this class.
- Tell me about your decision-making during the class lesson.
- I noticed you ______ (e.g. were teaching about evolution). What were your goals and objectives for this lesson? How well do you think these were promoted? What did you want your students to learn from this?
- Why did you decide to ______ (e.g. show the video)?
- What do you think went well with this lesson?
- Why do you think ______ (e.g. using hands-on activities) is important?
- If you could change this lesson now that it’s over, what would you change?
- How well do you think your students understand this concept? How do you know? How do you tell if a student is struggling?
- How do you decide the (order of the) content you’re teaching your students? Why?
- When you’re thinking about your teaching, what do you find yourself thinking about most?
- How does your current practice compare to where you want to be?
- What is causing you from not reaching the ideal yet?
- How do your colleagues, administrators, students, parents treat you?
- Describe your working relationship with your administrators, parents, students, other teachers.
- How has the teaching experience compared with what you learned in your science methods courses?
- What prior experiences seem most valuable to you now in your teaching career?
Before I began my Ph.D. program at Iowa State University, I thought I was a pretty good teacher. After three years at ISU, I realize I still have much to learn!

I give many thanks to my major professor Dr. Michael Clough for his expertise, patience, feedback, trust, and Hershey’s Kisses. Dr. Joanne Olson has been instrumental in guiding my teaching and research, always helping me strive for sound pedagogy and methodology. Both have modeled classroom teaching and decision-making in their most effective forms. I am also grateful to the other members of my POS Committee, Dr. Jim Colbert, Dr. David Owen, and Dr. Mack Shelley, for their expertise, questions, and guidance through my program and dissertation work. The ten teachers who participated in this study deserve my utmost thanks for their willingness to invite me into their classrooms and professional experiences. Fellow graduate student Joe Taylor has been a valuable resource and colleague during our research endeavors.

Shortly before I completed my written exams and began my dissertation fieldwork, God placed the loveliest lady in my life. Laura and I met at just the right time. The months and long hours committed to my dissertation were peppered with jubilant respites—ice cream, dinners, movies, shopping, sharing writings, worshipping, exercising, cooking, babysitting, talking, and more. I look forward to a lifetime of these experiences and more.

My family has been instrumental in my development as a learner and human being. My parents Bob and Vicki support me in more ways than I deserve. Greg, Kate and Josh model the life and family I aspire to emulate. Cathlina answers grammatical questions and shares the latest school joke. I am blessed to know you not only as family but also as friends.
My church family at North Grand Christian Church in Ames has been especially supportive and generous with their kind words and prayers. They provide encouragement and help me stay connected to the important, eternal matters in life. “And whatever you do, whether in word or deed, do it all in the name of the Lord Jesus, giving thanks to God the Father through him” (Colossians 3:17).

Finally, a huge pile of thanks goes to my personal CD collection and favorite CD selections from the Ames Public Library. Beethoven, Rossini, The Presidents of the United States of America, too many anime soundtracks, and every other magically musical disk made the experience more tolerable and even enjoyable. We did it, my little plastic friends!
BIOGRAPHICAL SKETCH

Daniel Bergman was born and raised in the community of O’Neill, Nebraska. He attended the University of Nebraska-Lincoln and played trumpet across the nation with the Cornhusker Marching Band. After completing his Bachelor of Science degree in Secondary Science Education, he worked at Aurora High School in Aurora, Nebraska. He taught chemistry, physics, and biology; and performed several roles including drama director, Future Problem Solvers sponsor, junior class sponsor, and member of several academic and district committees. In his five years of full-time teaching, Daniel completed two Master of Arts degrees: Curriculum and Instruction (Science Education concentration) through UNL and Education Administration (7-12 Principalship) through the University of Nebraska at Kearney.

This dissertation is the culmination of Daniel’s three years at Iowa State University, where he worked as a research and teaching graduate assistant, teaching both elementary and secondary science teaching methods. During the year Daniel completed this dissertation, he also published two short stories: “The Peach Duchy” in Mount Zion Speculative Fiction Review (Vol. 2, No. 3) and “Third Date Curse” in The Writers Post Journal (May 2007).

In the fall of 2007, Daniel will begin work at Wichita State University in his position of Assistant Professor in Secondary Science Education. In all of his teaching and writing endeavors, Danny values personal relationships the most.