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Alignment of teachers’ educational goals and habits of understanding, action, reflection, and improving practice with the Iowa State University Secondary Science Teacher Education Program

by

Joseph Michael Taylor

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Education

Program of Study Committee:
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Iowa State University

Ames, Iowa

2007

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DEDICATION

Work on my graduate studies was interrupted in November of 2003 when I was mobilized with the 308th Quartermaster Company (U.S. Army Reserves), based out of Washington, Iowa, in support of Operation Iraqi Freedom. From February 2004 to March 2005 our unit was stationed at Logistics Base Seitz, located in Southwest Baghdad near the Baghdad International Airport. During this time I was privileged to serve with many dedicated and courageous soldiers. While most soldiers returned safely to American soil, many lost their lives. This thesis is dedicated to the soldiers stationed at Log Base Seitz whose lives were cut short while serving their country and working to improve the lives of the people of Iraq.

**Sergeant Ivory L. Phipps**, 44, serving with the 1544th Transportation Company of the Illinois Army National Guard; killed during a mortar attack on Logistics Base Seitz on March 17, 2004.

**Specialist Jeremy L. Ridlen**, 23, serving with the 1544th Transportation Company; killed by small arms fire on May 23, 2004, while conducting convoy operations in East Fallujah, Iraq.

**Sergeant Melvin Y. Mora**, 27, serving with the 245th Maintenance Company of the Army Reserves; killed during a mortar attack on Logistics Base Seitz on June 6, 2004.

**Sergeant Shawna M. Morrison**, 26, serving with the 1544th Transportation Company; killed during a mortar attack on Logistics Base Seitz on September 5, 2004.

**Specialist Charles R. Lamb**, 23, serving with the 1544th Transportation Company; killed during a mortar attack on Logistics Base Seitz on September 5, 2004.

**Specialist Jessica L. Cawvey**, 21, serving with the 1544th Transportation Company; killed by a roadside bomb while conducting convoy operations in Fallujah, Iraq, on October 4, 2004.

*The person who has lived the most is not the one with the most years but the one with the richest experiences.*

Jean Jacques Rousseau
# TABLE OF CONTENTS

## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>v</td>
</tr>
</tbody>
</table>

## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>vi</td>
</tr>
</tbody>
</table>

## ABSTRACT

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>vii</td>
</tr>
</tbody>
</table>

## CHAPTER 1: INTRODUCTION

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Purpose and Research Questions</td>
<td>1</td>
</tr>
</tbody>
</table>

## CHAPTER 2: A REVIEW OF THE LITERATURE

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Education in America: Peering Back</td>
<td>4</td>
</tr>
<tr>
<td>Current State of Science Teaching and Education</td>
<td>5</td>
</tr>
<tr>
<td>Science Teacher Shortage Issues</td>
<td>8</td>
</tr>
<tr>
<td>Solutions to Teacher Shortage Issues</td>
<td>10</td>
</tr>
<tr>
<td>Disparities Between Teacher Preparation Programs</td>
<td>11</td>
</tr>
<tr>
<td>Alternative Certification Programs: How Do They Fare?</td>
<td>12</td>
</tr>
<tr>
<td>Teacher Habits</td>
<td>14</td>
</tr>
<tr>
<td>Basis for Present Study</td>
<td>16</td>
</tr>
</tbody>
</table>

## CHAPTER 3: RESEARCH METHODS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary of Study Purpose</td>
<td>18</td>
</tr>
<tr>
<td>Review of Research Questions</td>
<td>18</td>
</tr>
<tr>
<td>Participants</td>
<td>19</td>
</tr>
<tr>
<td>Study Design</td>
<td>20</td>
</tr>
<tr>
<td><strong>Recruitment</strong></td>
<td>20</td>
</tr>
<tr>
<td><strong>Data Collection</strong></td>
<td>21</td>
</tr>
<tr>
<td><strong>Data Analysis</strong></td>
<td>26</td>
</tr>
<tr>
<td>Assumptions and Limitations</td>
<td>31</td>
</tr>
</tbody>
</table>

## CHAPTER 4: RESULTS AND ANALYSIS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary of Study</td>
<td>33</td>
</tr>
<tr>
<td>Review of Research Questions</td>
<td>33</td>
</tr>
<tr>
<td>Former and Current ISU SSTEP</td>
<td>34</td>
</tr>
<tr>
<td><strong>Former ISU SSTEP Licensure Requirements (Spring 2000 to Spring 2003)</strong></td>
<td>34</td>
</tr>
<tr>
<td><strong>Current Undergraduate ISU SSTEP Licensure Requirements</strong></td>
<td>34</td>
</tr>
<tr>
<td>Iowa State Science Education M.A.T. Licensure (Spring 2003 to present)</td>
<td>37</td>
</tr>
<tr>
<td>Teacher Case Analyses</td>
<td>39</td>
</tr>
<tr>
<td>Teacher F-1: 4th Year Teacher (Former Program)</td>
<td>40</td>
</tr>
<tr>
<td>Teacher F-2: 5th Year Teacher (Former Program)</td>
<td>49</td>
</tr>
<tr>
<td>Teacher F-3: 3rd Year Teacher (Former Program)</td>
<td>57</td>
</tr>
<tr>
<td>Teacher C-1: 2nd Year Teacher (Current Program)</td>
<td>67</td>
</tr>
<tr>
<td>Teacher C-2: 2nd Year Teacher (Current Program)</td>
<td>75</td>
</tr>
<tr>
<td>Teacher C-3: 1st Year Teacher (Current Program)</td>
<td>84</td>
</tr>
</tbody>
</table>
**Summary of Matching between Habits of Graduates and the ISU SSTEP**  
Findings for Research Question 1: Educational Goals for Students  94  
Findings for Research Question 2: Habits of ISU SSTEP Graduates  99  

**CHAPTER 5: DISCUSSION AND CONCLUSIONS**  
Implications  107  
Recommendations for ISU SSTEP  112  

**REFERENCES**  116  

**APPENDIX A: LETTER OF CONSENT FOR PARTICIPANTS**  121  

**APPENDIX B:**  
(1) – LSC Classroom Observation Protocol (COP)  122  
(2) – Modified SATIC* Coding Sheet  124  
(3) – Classroom Promotion of Student Goals  125  

**APPENDIX C: CLASSROOM GOALS QUESTIONNAIRE**  126  

**APPENDIX D:**  127  

**APPENDIX E:**  129  

**ACKNOWLEDGEMENTS**  131  

**BIOGRAPHICAL SKETCH**  132
LIST OF FIGURES

Figure 1: Visual framework illustrating teacher decision-making and their interactions 17
Figure 2: COP coding for Teacher F-1 42
Figure 3: Student goals questionnaire results for Teacher F-1 (N = 51) 44
Figure 4: COP coding for Teacher F-2 51
Figure 5: Student goals questionnaire results for Teacher F-2 (N = 78) 53
Figure 6: COP coding for Teacher F-3 60
Figure 7: COP coding for Teacher C-1 69
Figure 8: COP coding for Teacher C-2 78
Figure 9: Student goals questionnaire results for Teacher C-2 (N = 51) 80
Figure 10: COP coding for Teacher C-3 86
Figure 11: Student goals questionnaire results for Teacher C-3 (N = 22) 89
Figure 12: Average rating of student goals questionnaire 97
Figure 13: Average observed goal emphasis 99
# LIST OF TABLES

Table 1: Description of study participants ........................................................................... 20
Table 2. Required courses and credits (cr) of the former ISU SSTEP ........................................ 34
Table 3. Required courses and credits (cr) of the current undergraduate ISU SSTEP ............... 35
Table 4. Required courses and credits (cr) of the current graduate ISU SSTEP ......................... 38
Table 5: Summary of graduates’ habits matched to the ISU SSTEP ......................................... 94
Table 6: Number of student goals reported by teacher for their classrooms ............................. 96
Table 7: Alignment of habits between graduates and the ISU SSTEP ....................................... 100
Table 7: Alignment of habits between graduates and the ISU SSTEP ....................................... 108
Table 8: Alignment of habits between graduates and the ISU SSTEP (Taylor) ......................... 108
Table 9: Summary of habits matching between graduates and ISU SSTEP (Bergman) ............... 108
ABSTRACT

This study compares the extent to which the educational goals and habits promoted by the former and current Iowa State University Secondary Science Teacher Education Program (ISU SSTEP) transfer out into its graduates’ teaching practices. Investigated habits include graduates’ practices of understanding, action, reflection, and improving practice. Six teachers from the ISU SSTEP participated in this study. Three participants studied under the former program that included a single semester-length science teaching methods course. The other three participants graduated from the current program, which features a coordinated sequence of semester-length science teaching methods courses, and a semester-length course addressing the nature of science and its implications for teaching and learning science. Data collection included three classroom observations, teacher questionnaires and semi-structured interviews, questionnaires for students about perceived emphasis of educational goals, and analysis of classroom artifacts.

Data collected in this study is part of a larger study conducted under the direction of ISU science education faculty to determine the effectiveness of the current ISU SSTEP, and how it may be improved. Analysis of the data collected in this study illuminated factors that influence the transfer of ISU SSTEP goals and habits out into its graduates’ teaching practices. Suggestions are offered regarding how the ISU SSTEP might address some of these factors and improve the transfer of its promoted goals and habits out into its graduates’ pedagogical practices. However, some factors that interfere in the transfer of its promoted goals and habits may be beyond the control of the ISU SSTEP.
CHAPTER 1: INTRODUCTION

Effective teaching involves the orchestration of many non-trivial decisions, to include modifying the direction of a lesson on a moment-by-moment basis, probing students’ thinking through questioning and wait-time, providing individualized attention while tracking the class as a whole, conducting frequent formative assessments, and making value judgments (Good & Brophy, 1994; Jackson, 1990; MacKay & Marland, 1978; Shavelson, 1983). Effective teachers pull from a vast array of content and pedagogical knowledge to guide their thinking (Shulman, 1987). This decision-making occurs within a dynamic and continually adaptive environment (Leinhardt and Greeno, 1986). The classroom conditions change in unpredictable ways, and information arises during the act of teaching that by necessity must inform decisions as they unfold (Berliner, 1983; Clough, 2003b). The summative effect is that “both science subject matter competence and knowledge of effective science teaching practices are undeniable components of a sophisticated understanding of learning and teaching necessary for excellent science teaching in a variety of settings (Olson, 2005).” The extent to which science teachers master these skills varies tremendously. What factors appear to influence the likeliness that a teacher will succeed or fail? This question is addressed along several lines of education research, whether within the scope of investigating individual teachers, cohorts, science education preparation programs, in-service programs, or education policy.

Study Purpose and Research Questions

This study focuses on the Iowa State University Secondary Science Teacher Education Program (ISU SSTEP). The ISU SSTEP has evolved over the course of the past
several years. During the years 2000 to 2003, the science education portion of the ISU SSTEP consisted of a single one-semester science teaching methods course. Beginning with the 2003-04 academic year, the required science education coursework was significantly expanded. Undergraduate students in the new program complete three sequential science teaching methods courses, and students enrolled in the Master of Arts in Teaching (M.A.T.) program complete an additional fourth methods course after student teaching. Both the former and current ISU SSTEP programs will be extensively described in Chapter 4: Results and Analysis.

The study of the ISU SSTEP reported here is a small part of a larger study being carried out under the direction of ISU science education faculty. The study presented here included six ISU SSTEP graduates — three from the former program and three from the current program. A previous study by Bergman (2007) focused on ten ISU SSTEP graduates — five from the former program and five from the current program. Because both this and the Bergman study are part of a larger study of the ISU SSTEP, the research questions and methodology employed here are the same as that used in the Bergman study. Results of both studies will contribute knowledge pertaining to the effectiveness of the ISU SSTEP and suggest ways the current ISU SSTEP might improve its effectiveness.

The end result of this larger study is to determine the alignment of the understandings and teaching practices of graduates of either the former or current ISU SSTEP with the intended outcomes of the respective ISU SSTEP. Particular attention is given to the effectiveness of the revised current program as compared to the former program. This study does not evaluate nor make judgments on the effectiveness of any individual’s science teaching practice. It also does not attempt to assess the impact of either program on the
science achievement of secondary students. The research questions of this study fit within two broad 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 ISU SSTEP Graduates:

   a. What habits of 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?

   Answering these questions will help guide the future direction of the ISU SSTEP. This present study is a contribution to improving the preparation of science teachers.

   In order to understand the rationale behind the changes implemented to the ISU SSTEP, visualizing it within the historical emergence of teacher education in America is important. This will be addressed in Chapter 2: A Review of the Literature as a window into current efforts to more effectively train and equip science teachers.
CHAPTER 2: A REVIEW OF THE LITERATURE

Teacher Education in America: Peering Back

To understand the problems faced by current teacher preparation requires knowledge of the historical development of teacher education in America. Formalized teaching traces back to the colonial times, however in most cases teachers received little or no special preparation. Selection of teachers was typically administered by local reputable citizens, such as ministers and doctors, who typically based their decisions with more emphasis on personal knowledge of the applicant, to include moral character, subject matter proficiency, and classroom control (Bruxvoort, 2005; Lortie, 1975). It was not until 1839 that the first school was opened to provide systematic instruction to establish teaching as a formal profession (Borrowman, 1965; Goodlad, 1990).

Continued prosperity of the nation was seen to rest on ensuring that education was provided to all from an early age. From this need arose what became the first steps of public schools. A vast system of education was necessary, resting on a foundation of quality teachers. Formal education for teachers was needed to ensure consistent instructional practices (Bergman, 2007). The earliest teacher preparation programs started out in institutions known as “normal schools.” These schools produced teachers to meet the high demands across the nation.

The earliest curriculum for teacher preparation typically included a limited range of disciplines, to include reading, writing, arithmetic, spelling, geography, grammar, and in some instances limited amounts of physiology, history, ethics and religion (Borrowman, 1956). Later developments attempted to align the curriculum with a range of subjects taught
at academies or colleges, to include algebra, geometry, natural science, and moral philosophy. During its infancy, teacher preparation included little emphasis on pedagogy. Teaching pedagogy was typically limited to providing hints for classroom management and establishing routines (Goodlad, 1990). By 1900, teacher preparation schools began to experience a more rapid progression, slowly emerging as institutes with a level of academic rigor similar to colleges.

During this time a transition took place in which more colleges provided programs in teacher preparation, and schools devoted entirely to teacher preparation began to diminish in number. Teacher licensure moved from the hands of local school boards to state certification, which included coursework that was provided only by colleges and universities (Yager & Penick, 1994). By 1940, these original teacher preparation schools had evolved into other kinds of institutions (Bruxvoort, 2005), and by the 1970’s we find that schools of education usually resided within colleges and universities.

In the midst of the establishment and development of teacher preparation schools, and even later as such schools were absorbed by colleges and universities, there existed what is perhaps best described as a splintered identity (Bruxvoort, 2005). Schools struggled to identify the core areas needed to prepare effective teachers. The tension that existed then continues today, as evidenced by the difficulties in developing science teacher preparation programs that balance the teaching of content knowledge, pedagogical knowledge, and pedagogical content knowledge.

**Current State of Science Teaching and Education**

While education literature is rich with studies describing the state of education at least as far back as the early nineteenth century, this present review will focus only on studies
within the recent past. The Goodlad Study (1983b), earmarking the findings published in *A Place Called School* (Goodlad, 1983a), captured the state of education in America during the latter 1970’s and early 1980’s. The study was powerful in its description of the typical classroom experience of children, drawing attention to a large number of discouraging pedagogical strategies shared by a majority of teachers. To identify a few instances,

- Teachers dominate verbal communication, accounting for 75% of all classroom talk time;
- Quality learning gets lost in the midst of other low payoff classroom activities, such as “preparing for and cleaning up after assignments, listening to teachers explain or lecture, and fulfilling written assignments (1983a);”
- Only 12% of classroom time was associated with activities that were identified as substantive;

These findings concerning education as a whole apply equally to science education, as evidenced by the following:

One would expect the teaching of social studies and science in schools to provide ample opportunities for the development of reasoning: deriving concepts from related events, testing in a new situation hypotheses derived from examining other circumstances, drawing conclusions from an array of data, and so on. Teachers listed those skills and more as intended learnings. We observed little of the activities that their lists implied, and teachers’ tests reflected quite different priorities—mainly the recall of information. The topics that come to mind as representing the natural and social sciences appear to be of great human interest. But on the way to the classroom they are apparently transformed and homogenized into something of limited appeal (Goodlad, 1983a, p. 468)

At the time of its publication the Goodlad Study was influential within the education community, and has continued to serve as a hallmark study. A recent search on Google Scholar estimates that 841 publications cite Goodlad’s report (2007). The report highlighted a number of basal problems in elementary and secondary education, and pointed toward the future of education, stating that “if school improvement continues on its present course, our schools will remain very much as they are (Goodlad, 1983a).” However, in spite of the
troubled state of teaching, Goodlad pointed toward a case for optimism. This optimism for the future of education was likened to an optimism for the rest of our society. Goodlad (1983a) writes:

We are slowly coming to realize that many of the principles and models that have guided such things as our economic development, land use, energy use and distribution, and management are anachronistic. As we come to better understand the irrelevance of these principles and models, we will presumably align our practices with more appropriate theories. The same must occur with regard to education in schools.

Over twenty years have elapsed since the publication of the Goodlad Study. One would hope that the optimism in Goodlad’s words regarding the eventual alignment between theory and practice would have reached fruition. Unfortunately, this is not so. Current research continues to point to the repetition of ineffective science instruction (Weiss, 2003).

While many factors contribute to the failure to instill effective science teaching into our society, perhaps one of the most prominent is the lack of widespread, quality science teacher preparation programs. It would seem that the concept of an effective preparation program, to include its philosophical foundations, goals for preservice teachers, and curricular structure, should slowly progress toward a model that would reach consensus. However, in recent years the disparity between preparation programs has widened. This is perhaps due to a number of disagreements and naïve views on effective teaching held by key stakeholders, to include policy makers, teacher educators, teachers, parents, and the general public.

For instance, the public’s prevailing view of the profession of teaching can be characterized as an interwoven set of contradictory expectations and values. Bruxvoort (2005) states that “teaching is described as honorable while simultaneously referred to as
easy; teaching is noble as well as reserved for those who can’t do otherwise.” Compounding this contradiction is the comparable salary gap between teachers and those with substantially less education (Farkas, Johnson, & Foleno, 2000; Goodlad, 1990). The public’s pervasive attitude towards the profession at times equates teaching with a form of childcare, not as an intellectually intensive and time demanding quest to educate learners.

Additional misconceptions about the profession of teaching are evident. Clough (2003) describes several persistent views that underscore the common naïve conceptions about effective teaching, including such notions as

- a command of subject matter is sufficient for effective teaching;
- effective pedagogical practices develop naturally through teaching experience;
- teaching is simply a matter of personal style; and
- teaching is essentially the passing of information from teacher to students.

It is especially problematic when those who have the largest influence on the direction of science teaching, to include science teacher educators and policy makers, hold such naïve views. Perhaps one of the most evident examples is the endorsement by many science teacher educators and policy makers of a number of licensure programs that push preservice teachers through short, non-intensive training. An overview of teacher preparation programs will be considered in this review. This will be set within the context of a wider consideration of the emergence and proliferation of teacher education in America.

**Science Teacher Shortage Issues**

The rigor, depth, and duration of science teacher preparation vary widely from program to program, and from state to state. While there are many reasons why standards vary, one significant reason has been in response to the increasing shortage of qualified
teachers, especially in the areas of math, science, and technology (Craven & Penick, 2001), and the subsequent need to select and train individuals to enter into the classroom.

This shortage cannot simply be distilled down to a common-view problem of supply and demand, in which there exists fewer teachers than there are positions. To the contrary, there is presently an adequate supply of qualified teachers in most science content areas to meet the nation’s needs (MacIsaac, 2004; Darling-Hammond, 2000; 2001). Chemistry and Physics are two science content areas currently listed as having fewer teachers than positions (AAEE, 2003), but in fact many schools still receive dozens of qualified applicants for each position (Darling-Hammond, 2003). The underlying problem instead lies along two other lines. First, a well defined subset of schools have difficulties attracting qualified teachers. This problem, due to what Darling-Hammond (2003) calls “distributional inequities”—especially in areas with poor and minority pupils—result from disparities in pay and working conditions, interstate barriers to teacher mobility, inadequate recruitment incentives to hiring systems that discourage qualified applicants, and financial incentives to hire cheaper, less qualified teachers. These situations are most prominent in rapidly growing rural and urban areas.

Second, there exists an inability to retain qualified teachers for the long term. Factors that discourage long term retention include inadequate preservice preparation, low support from school administrators, student discipline problems, limited faculty input into school decision-making, and to a lesser extent, low salaries (Darling-Hammond, 2003; Ingersoll, 2001; Mangruband, 2005). Ingersoll (2001) writes

Rather than insufficient supply, [we conclude from the data] that school staffing problems are primarily due to excess demand, resulting from a ‘revolving door’—where large numbers of teachers depart their jobs for reasons other than retirement.
Thus, [from the data we suggest] that the solution to staff problems does not primarily lie in increasing supply, but rather in decreasing demand (p. 501).

Bureaucracy plays a key role in retention problems. Weiss (1999) says

Too many new teachers become initiated into a profession that too often sets them up to fail. The system seems to neglect the fact that new teachers are exceptionally vulnerable to the effects of unsupportive workplace conditions, precisely because, never having taught before, they lack the resources and tools to deal with the frustrations of the workplace (p. 869).

**Solutions to Teacher Shortage Issues**

Regardless of the ultimate sources of teacher shortage problems, there has been a surge of new and creative efforts to attract and train more teachers. One of the most widespread strategies has been to circumvent conventional certification by significantly reducing the requirements for earning teacher licensure (Darling-Hammond & Youngs, 2002; Galley, 2004; Keller, 2004; Windschitl, 2005). Such programs, in which non-traditional approaches to license teachers are used, are commonly referred to as “alternative certification” programs (Tom, 1991). Examples of deviations away from traditional licensure requirements will help draw out how the differences are significant.

Some states have removed a student teaching requirement (NASDTEC, 2000), in which the preservice teacher develops their skills under the close supervision of a seasoned teacher. Other states bypass any conventional instruction. The New Jersey school system approved the hiring of individuals who have never received formal teaching preparation, so long as they have a bachelor’s degree in a content area and pass a state test in that content area (Newman, 1990). Another strategy has been to recruit in previously untapped sources, such as retirees, former military, and professionals seeking mid-career changes (Bradshaw, 1996).
Many other accelerated programs abound. The Texas educator-certification board approved a program in which any person with a bachelor’s degree who passes both a subject-matter and a pedagogy exam would receive a teaching certificate (Galley, 2004). Georgia offered a similar program that is only slightly more comprehensive. Certification is awarded to anyone with a degree in the subject they intend to teach (or a subject closely related) who passes three widely used teacher tests (Keller, 2004). Some programs require even less. The state of Idaho now grants teacher certification based solely on successful completion of online exams administered through the American Board of Certification of Teacher Excellence (U.S. Department of Education, 2003). This trend of minimal preparation is growing. There is an increasing appeal to develop “state-approved alternative routes to certification, some of which…offer only a few weeks training that do not include learning theory, child development, or content-specific methods (Windschitl, 2005).”

**Disparities Between Teacher Preparation Programs**

Several programs provide professionals the opportunity to quickly integrate into the role of teaching science. Two examples are *Teach for America* (TFA) and *Project ACT-NC TEACH*. TFA works with graduating college seniors who commit two years to teach in urban and rural public schools identified as experiencing teacher shortages (Bradshaw, 1996). *Project ACT-NC TEACH* is an accelerated teacher preparation program for those already holding degrees and who want to change professions. The program requires a five-week essential skills component, employment on a Lateral Entry License, and attendance with university faculty one Saturday per month during their first year of teaching (Bradshaw, 1996). The program recently implemented an alternative that is entirely on-line, utilizing an Internet platform called Blackboard to complete coursework.
Alternative Certification Programs: How Do They Fare?

*Teach for America* gained support as a novel initiative to address the growing need for quality teachers, especially in the neediest areas of rural and poor urban public schools. Many program advocates point to *Teach for America* as a success, however a number of research studies say otherwise. “Our results directly contradict claims made by *Teach for America* advocates that enthusiasm and subject-matter knowledge, as well as a general education in a prestigious university, prepare the recruits to adequately teach in U.S. classrooms (Laczko-Kerr & Berliner, 2003, p. 38).”

According to Darling-Hammond (1997), “four separate evaluations found that *Teach for America’s* training program did not prepare candidates to succeed with students, despite the noticeable intelligence and enthusiasm of many of the recruits.” Laczko-Kerr and Berliner (2003) compared student performance on the Stanford Nine (SAT-9) standardized tests of students taught by teachers trained through *Teach for America*, under-certified programs, and certified programs. These authors found no statistically significant difference in mean scores between the former two groups, but in all instances students who have a certified teacher scored higher. They concluded that “common sense and empirical data agree: Those who have trained longer and harder to do the complex work of teaching do it better (p.38).”

Many teachers who trained through *Teach for America* rated their preparation more poorly than those from traditional certification programs (Darling-Hammond, Chung, & Frelow, 2002; Laczko-Kerr & Berliner, 2003). Jonathan Schoor, who prepared as a teacher through *Teach for America*, wrote of his experience: “I was not a successful teacher, and the loss to the students was real and large (1993, p. 318).”
Darling-Hammond summarized the *Teach for America* program as “fostering simplistic approaches to teaching that have little or no grounding in knowledge about how students learn or what teaching strategies may be effective and that offer no prospect of helping recruits meet professional standards of practice (1994).” While the program has been revamped, Darling-Hammond concludes that the new approach still offers no systematic curriculum, continuous faculty, mentoring, or quality control over assessment (1994).

Many alternative licensing programs have had extremely low retention rates. The *Los Angeles Teacher Trainee Program*, California’s largest district-run internship program, lost 20% after the first year of training, and another 15% after the second year (Wright, McKibbin, & Walton, 1987). The *Teaching Fellows Program* in New York lost more than 15% of its first cohort by midyear and more than 30% by the end of the first year (Goodnough, 2000). *Teach for America* had some of the lowest retention rates. One cohort, comprised of seven high-potential recruits, had been reduced to two after two years. One of the two was later fired, leaving only one of the original seven remaining in the profession. Alternative certification programs were thought to hold promise by attracting more diverse, mature, academically able teachers (Zumwalt, 1996), who were expected to have a more stable base, stay longer in the profession, and therefore slow the revolving door of teachers. Yet studies have argued that alternative certification programs do not hold up this promise (Jorissen, 2003). Zumwalt went on to say

> Although initially more likely to teach in urban schools either because of personal choice or necessity, there is little evidence indicating that alternative certification teachers are less likely to flee urban schools or are generally more responsive to the needs of urban students. Much depends on their personal histories and the nature of their abbreviated preparation programs (1996, p. 42).
In terms of pedagogical knowledge and pedagogical content knowledge, teachers trained through alternative certification tend to be more limited in their view of curriculum and in their understanding of student ability and motivation; experience difficulty in translating that content knowledge into information that students can understand; plan and organize instruction less effectively; and not learn what they need to know about the act of teaching from experience (Bradshaw, 1996, p. 7).

Describing the apparent ineffectiveness of many alternative licensing programs is two-fold. First, it serves as a cautionary note to highlight a growing trend in science teacher preparation. This trend has captured the attention of many stakeholders, especially amidst the shortage of qualified science teachers (Cavallo, Ferreira, & Roberts, 2005; Darling-Hammond, 1994; Lerner & Zittleman, 2002; Weiss & Boyd, 1990). Second, it is used here to segue into the revamping of the Iowa State science teacher licensure program. In many ways the outcomes of earlier Iowa State programs (prior to 1999) bore resemblance to alternative licensing programs, and there has been a revitalized effort at Iowa State to improve the effectiveness of its science education program. The program began with a single 4-week science methods course for undergraduates, but now includes a sequence of three methods courses for undergraduates and a sequence of four methods courses for Master of Arts in Teaching (M.A.T.) students. Each program is described in greater detail in Chapter 4, however first it will be necessary to consider the guiding philosophy underlying the ISU SSTEP.

**Teacher Habits**

“A teacher affects eternity; he can never tell where his influence stops.” This quote by Henry Adams (1928) captures the nostalgia felt by many when they think back to an influential person during their education. Through the eyes of the learner, a teacher was seen
as energetic, passionate, caring, and perhaps a motivator. Systematically defining all essential traits needed to become an effective teacher would be a daunting task, as there is no formula describing all qualities one must possess. There is a popular adage that teachers are born, not made. While this simplistic description is problematic, it does allude to an observation that the most effective teachers have a special combination of innate traits and learned expertise. We have all known a teacher who should never have stepped into a classroom. Perhaps they had no sense of humor, or could not relate with students. Others tried to serve the role of “big brother” or “big sister,” but could not fill the role as educator.

The driving force of the ISU SSTEP is to take capable individuals with the passion to teach, and aid them in developing the understandings, skills, and habits of thinking necessary to successfully implement effective education (Clough, 2003). Gaining understanding takes more than just experience alone (Berliner, 1994; Fenstermacher & Richardson, 2005), as evidenced by the following:

“There has been some literature about the roles of teaching experience in teachers’ teaching abilities. By and large, the literature (and common sense) argues that as teachers become more experienced in teaching, they should have larger repertoires of teaching strategies, see a wider band of classroom situations more richly, etc. And as teachers become more experienced, they have a greater likelihood of becoming expert teachers. But, as a caution, expert teachers are always experienced but experienced teachers are not always expert (Strauss, et. al., 1998, p. 581.)”

That experience is not sufficient as a teaching agent is underscored by Darling-Hammond:

“While people do learn from their experience, they do not always learn the right things. Without guidance in interpreting practice and relating it to a knowledge base that can inform decisions, teachers can draw the wrong inferences about why things went wrong and what to do about it (1994, p. 28).”

Attempts to simplify teaching are dangerous because of the potential misdirection that may result (Bergman, 2007; Buchman, 1988). To the contrary, effective teachers pull from a vast
array of content and pedagogical knowledge to guide their thinking (Berliner, 1983; Shulman, 1987). Decision-making occurs within a dynamic and continually adaptive environment (Leinhardt and Greeno, 1986), in which the classroom conditions change in unpredictable ways (Berliner, 1983).

Effective decision-making in the classroom results from considering both the situational context and an understanding that is based upon solid research (Borko, 1996). The ISU SSTEP makes use of a visual representation called the “Research-Based Framework (RBF) for Teaching and Learning Science (Figure 1)” (Clough, 2003b; Clough & Berg, 2006; Clough & Kauffman, 1999). The culmination of behaviors and practices reflective of a teacher’s understanding of effective teaching are described as the habits internalized by such a teacher. ISU SSTEP faculty have identified four broad habits promoted, modeled, and advocated in this program: (1) understanding, (2) action, (3) reflection, and (4) having and enacting an action plan for improving practice (Bergman, 2007).

**Basis for Present Study**

This study contributes to a larger project directed by the science education faculty at Iowa State University. The focus of this study, like that of Bergman (2007) is to determine the degree of alignment between the habits exhibited by teachers and the goals promoted in their classroom and comparing them to those promoted within the ISU SSTEP.

One limitation is that this study investigates only one secondary science education program. However, as noted by Bergman, “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 (2007).”
Science teacher education programs are vital to the educational success of our country. Research into the restructuring of the ISU SSTEP will produce valuable knowledge regarding the impact on graduates of this restructuring. The ISU SSTEP advocates development of the habits of understanding, action, reflection, and improved practice. The extent to which teachers exhibit these habits within their classroom is a reflection of the success of this program. Only by studying the effects of these changes will teacher education in turn make changes that impact science teacher education in the future.

Figure 1: Visual framework illustrating teacher decision-making and their interactions (Clough & Berg, 2006).
CHAPTER 3: RESEARCH METHODS

Summary of Study Purpose

The purpose of this study is to determine the extent to which the teaching practices of graduates of the former or current ISU SSTEP align with the intended outcomes of the programs. Six science teachers participated in this study. Three participants graduated from the former ISU SSTEP, and three from the current ISU SSTEP. Requirements for these two programs are described in Chapter 4. Conclusions drawn from this study will provide knowledge about the effectiveness of the ISU SSTEP, and guide decisions regarding ways to improve the future of the ISU SSTEP.

Review of Research Questions

The research questions of this study fit within two broad 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 ISU SSTEP Graduates:
   a. What habits of understanding, action, reflection, and improving practice do former and current ISU SSTEP graduates exhibit?
   b. How do these compare to the habits promoted and modeled in ISU SSTEP?

Answering these questions will help guide the future direction of the ISU SSTEP. This study does not evaluate nor make judgments on the effectiveness of any individual’s science
teaching practice. It also does not attempt to assess the impact of either program on the science achievement of secondary students. This present study is a contribution towards these overarching goals to improve the preparation of science teachers.

Participants

The participants of this study fit within two categories. The first category includes those undergraduates who completed their licensure under the former ISU SSTEP. The second category includes both undergraduate and graduate (MAT) students who completed their licensure under the current ISU SSTEP. A description of each of these programs is discussed in Chapter 4.

Over 120 individuals have graduated from the ISU SSTEP since revisions were introduced in the year 2000. Ten of these graduates took part in a dissertation study conducted by Daniel Bergman (2007). This present study includes six additional graduates from the ISU SSTEP. The analysis and conclusions from both of these studies will be included in the larger study of those completing the ISU SSTEP from 2000 through 2006.

Of the six participants, three graduated from the former ISU SSTEP (designated as Teachers F-1 through F-3), and the other three graduated from the current ISU SSTEP (Teachers C-1 through C-3). All teachers in this study are Caucasian, ranging in age from 24 to mid-forties. Five of the participants are male while one is female. Participants were selected out of convenience by their proximity to the ISU campus. All participants taught in public schools in a middle or high school. The teachers who graduated under the former program have taught from between three and five years. Teachers from the current program were either in their first or second year of teaching. A summary of the demographics of the participants is provided in Table 1.
Table 1: Description of study participants

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Years of Experience</th>
<th>Age</th>
<th>Sex</th>
<th>Teaching Assignment</th>
<th>Location (Iowa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-1</td>
<td>4</td>
<td>Mid-40’s</td>
<td>M</td>
<td>9-12th Grade Biology 11-12th Grade Anatomy Physiology</td>
<td>Suburban</td>
</tr>
<tr>
<td>F-2</td>
<td>5</td>
<td>28</td>
<td>M</td>
<td>10th Grade Biology 11-12th Grade Advanced Biology</td>
<td>Rural</td>
</tr>
<tr>
<td>F-3</td>
<td>3</td>
<td>29</td>
<td>M</td>
<td>8th Grade Science</td>
<td>Rural</td>
</tr>
<tr>
<td>C-1</td>
<td>2</td>
<td>35</td>
<td>M</td>
<td>11-12th Grade Physics Principles of Chemistry</td>
<td>Suburban</td>
</tr>
<tr>
<td>C-2</td>
<td>2</td>
<td>30</td>
<td>M</td>
<td>10th Grade Biology 10-12th Grade Chemistry</td>
<td>Suburban</td>
</tr>
<tr>
<td>C-3</td>
<td>1</td>
<td>24</td>
<td>F</td>
<td>9th Grade Health 9-12th Grade Biology</td>
<td>Suburban</td>
</tr>
</tbody>
</table>

**Study Design**

The design of this study aligns with the dissertation completed by Bergman (2007), and together these form a portion of a larger research study examining the extent to which the ISU SSTEP affects the teaching practices of science teachers who graduated from one of the two programs. Multiple areas of evidence are compiled to synthesize a robust description of the teaching practices and understandings held by science teacher participating in the study. Creating these synopses “prompts readers to make comparisons to their particular circumstances (Bergman, 2007).” In this sense it is hoped that the results of this study will not only inform those involved with the ISU SSTEP program, but will serve the wider science education community.

**Recruitment**

Participants were selected from the pool of graduates of the ISU SSTEP since the year 2000. Selection was based upon a number of criteria, to include each participant must
be currently teaching, equivalent numbers of graduates from both programs, proximity to the researchers location, a broad range of school demographics, and a representative range of performance while in the ISU SSTEP as determined by the science teaching methods instructor.

The ISU faculty member who teaches secondary science methods made the initial contact with subjects in this study asking them to participate in the study. A letter was mailed with two documents. The first was a letter of consent describing the study and requesting participation (*Appendix A*). The second was a letter of consent to be signed by the building principal allowing members of the research team to visit the school to conduct research.

*Data Collection*

Participants were asked to select days that were representative of their instructional practices. For example, researchers avoided days when testing was administered, class periods were severely shortened, large numbers of students were expected to be absent due to field trips, and such.

*Classroom Observations*

Each participant was observed by a member of the research team on three occasions. When possible, the participant was observed on consecutive days to follow the progression of instruction and to understand how decisions were made throughout the lesson sequence. In some instances observations could not be completed over consecutive days. In such circumstances, when possible, the teacher was interviewed to determine the intended instructional sequence for the next lesson.
During each observation several instruments were used to code teacher behaviors. Each of these instruments is described below, and is available in Appendix B.

**Local Systemic Change (LSC) Classroom Observation Protocol (COP):** The LSC COP (Appendix B1) is an instrument designed to assess several dimensions of science instruction, including the design, implementation, science content, and classroom culture (HRI, 2006; Weis, 2003). The LSC COP was selected as an evaluating instrument because of its holistic assessment of teacher behaviors before, during, and after instruction. The validity the LSC COP has been established by way of expert review (Banilower, 2005).

Each category is rated on a scale of 1 to 5 based upon the extent to which the lesson, content, or classroom is reflective of the *National Science Education Standards*, or NSES (NRC, 2006). A rating of 1 is assigned when the category observed is not at all reflective of the NSES, while a 5 is assigned when the category observed is highly reflective of the NSES. Upon rating the four categories, a final “capsule rating” is assigned. Determining this rating is accomplished by considering all available information about the lesson, its context and purpose, and your own judgment of the relative importance of the ratings you have made. Select the capsule description that best characterizes the lesson you observed. Keep in mind that this rating is not intended to be an average of all the previous ratings, but should encapsulate your overall assessment of the quality and likely impact of the lesson (HRI, 2005).

The capsule rating has eight categories spread along five levels. The first level rating is describes “ineffective instruction” in which either students are passive recipients of information or do activities that have no clear purpose or link to conceptual development. The second level describes instruction that contains “elements of effective instruction,” but exhibits serious problems. Examples include content that lacks importance and/or
appropriateness, and instruction that is unsuccessful in addressing difficulties experienced by students.

The third level describes the “beginning stages of effective instruction,” divided into three stages of low, solid, and high. At this level, instruction bears several effective elements, but with some weaknesses. For example, the teacher may have “short-circuited” an exploration by telling students what they should have seen, instruction may overlook the needs of many students, or the classroom culture may hinder the lesson.

The fourth level is described as “accomplished, effective instruction.” At this level the teacher provides meaningful work that is well-designed for most students. This might include investigations, teacher presentations, or discussions with other students or the teacher. The only deficit at this level is that the teacher hasn’t adapted the content or pedagogy in response to student needs or interests. Level five describes exemplary instruction. Students are highly engaged most or all of the time as a result of the teacher’s well-designed implementation of instruction. The teacher perceives the needs and interests of students, and modifies instruction in response.

All members of the research team completed a training session on this instrument to achieve a high level (>0.85 on each category) of intercoder agreement. This training was led by a faculty member who had completed training through Horizon Research, Inc., the developer of LSC COP.

*Schlitt Abraham Test of Interaction Coefficients (SATIC)*: Developed at Florida State University in 1973 by Michael Abraham and Dorothy Schlitt, SATIC (*Appendix B2*) is an instrument used to track instances of pre-defined verbal and non-verbal teacher behaviors (Abraham & Schlitt, 1973). The instrument identifies six verbal initiatory behaviors, eight
verbal response behaviors, and four non-verbal response behaviors. SATIC is heavily used in the ISU SSTEP to help prospective teacher become aware of their behavior while teaching, reflecting on that behavior, and change their behavior to improve teaching and learning. Students received extensive training and practice, to include tape recording themselves as they teach and self-assessing their interaction patterns. Particular emphasis is placed on identifying trends in initiatory questioning, the use of wait-time I and II, and responding to students’ responses. Accurately identifying these aspects of interaction fosters identifying and developing an ideal interaction pattern based upon initiating with thought-provoking questions, using an appropriate length of wait-time, and responding in ways that seeks elaboration or makes use of students’ ideas.

**Emphasis of Educational Goals for Students:** Prospective teachers in the ISU SSTEP develop a list of educational goals for students. While the wording differed slightly amongst cohorts, the overall package of goals was always quite similar (Clough, 2003) and includes goals appearing in Appendix B3. The ISU SSTEP emphasizes the importance of these goals and how to promote them. When observing teachers in this study, researchers assessed the extent that such goals were promoted. Each goal listed was assigned a number, either zero, one, or two, reflecting the extent to which the goal was promoted in that lesson. These values represent no promotion, moderate promotion, and extensive promotion, respectively. A small number of observations were completed by two researchers at the same time, and afterwards the scores were compared, which resulted in a high level of confidence that scores were consistently assigned amongst researchers.

**Student Questionnaire about Educational Goals**
An additional instrument was a goals questionnaire (Appendix C). Teachers in the study provided the same list of goals to their students as a non-graded activity. Student participation was optional and anonymous. Listed on the survey are the same twelve goals as on the previous instrument. Students were asked to consider each goal, and rate on a scale of one to five to what extent they feel that each goal is emphasized within their classroom. The student questionnaire is included in this study as a means to compare what students perceive is being emphasized in their classroom with what goals teachers and researchers think are promote.

**Teacher Interviews and Questionnaires**

Participants were asked to complete an online questionnaire prior to classroom observations (Appendix D). This questionnaire provided researchers with biographical information, their teaching history, and impressions of their teacher preparation program. This information was reviewed prior to classroom observations, and helped in developing questions to ask during a semi-structured interview following observations. These interviews were conducted either immediately following a lesson, if the teacher was free, or by telephone. Interviews provided additional information that could not be obtained through observation. Questions were written prior to the interview (Appendix E), however questioning ultimately followed the flow of conversation based upon participant responses.

Interviews typically followed a common sequence. Initial questioning probed into the teachers’ thinking and decision-making regarding how they planned and carried out their lesson. Questioning next focused on self-reflection in an effort to determine what knowledge bases, if any, informed their decision-making. An additional emphasis was posing questions
to determine to what extent teachers were self-aware of their current teaching habits, and how these aligned with their desired habits.

**Classroom Artifacts**

Participants shared samples of classroom materials including assignments, handouts, notes, assessments, lesson plans, activities, instructions, rubrics, and more. In some cases teachers provided extra copies of these materials. In other instances originals were borrowed, photocopied, and returned. Other teachers chose to e-mail materials as attachments or burned materials to a CD. These artifacts were used in conjunction with other data sources to assess what goes on in subjects’ classrooms. They also provided triangulation in forming case studies and analyses of each teacher.

**Data Analysis**

A teacher case analysis was developed for each of the participants using each of the data sources. Conclusions were formed by triangulation of data sources. Teacher case analyses are discussed in *Chapter 4*.

**Educational Goals for Students**

The extent to which goals for students were promoted within the classroom was determined through a number of data sources. The on-line questionnaire and interview responses provided insight into what goals the teacher claims is promoted in their classroom. The student survey addressed which goals students perceived to be promoted by the teacher. The culmination of interviews, artifacts, observations and coding instruments were used to complete the picture of to what extent student goals are emphasized.
Teachers’ Habits
ISU SSTEP faculty have identified four broad habits promoted, modeled, and advocated in this program. These are described by Bergman as

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 (2007).

Chapter 4 includes a summary of each participant and their rating under each of the four habits. Ratings were determined from several exemplars within the collected data sources. Under each of the four subcategories, a participant could receive one of three ratings, a high (H), moderate (M), or low (L) match. Researchers involved with this study discussed criteria for determining which rating to assign. A description for each subcategory, succinctly summarized by Bergman (2007), is as follows:

Habits of Understanding were assessed mainly through data from interviews and artifacts. A high match (H) to the 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 the ISU SSTEP. Teachers who were ambiguous in their descriptions of interactions, goals and rationale for these decisions received a low (L) match rating to the ISU SSTEP.

**Habits of Action** were assessed using the observation field notes, artifacts, and goal promotion data sources to determine relative matching to the ISU SSTEP. Classroom observation coding tools were used to determine the alignment of this habit 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 the 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 the 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 the 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 the 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 the 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 the 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 the ISU SSTEP was determined for each participant based on the four categories of habits 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 promoted, advocated, and modeled in the 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 the 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 and Limitations

Several assumptions exist within this study. Participants’ responses to the online questionnaire and interview are assumed to accurately reflect their experiences and perceptions. The assumption was made that students’ perceptions of goal emphasis accurately reflected what actually transpired in a course. Observations and artifacts were assumed to be representative of the teachers’ typical use of curriculum and instruction. In an effort to address these limitations, several data sources were collected and analyzed to provide a degree of triangulation (Denzin, 1970).

Important differences exist between the former and current ISU SSTEPs, as well as between the current M.A.T. and undergraduate ISU SSTEPs.

1. The current ISU SSTEP includes far more time studying science teaching methods, and that time extends over a longer period. Moreover, graduates of the current program have twice the number of hours in schools prior to student teaching. Finally, the current program includes a course devoted to the nature of science, its implications for teaching and learning science, and how to effectively teach it to secondary school students.

2. Current ISU SSTEP M.A.T. students complete a science teaching methods course during their student teaching semester, and a fourth science teaching methods course after student teaching. Undergraduate students of both the former and current ISU SSTEPs completed student teaching without concurrent science teaching methods course work.

3. Former ISU SSTEP graduates completed their program prior to graduates completing the current program. Thus, they have more teaching experience and are likely older than graduates of the current program. This additional experience may suggest that former ISU SSTEP graduates have had time to further develop and internalize the habits
promoted by ISU SSTEP and thus will more closely match those habits. However, with time they have become further removed from the program, and ideals promoted by ISU SSTEP may no longer be at the forefront of their minds. They may be unconsciously competent—enacting particular habits promoted by ISU SSTEP, but unable to articulate those.

The extent to which the above confounding variables affect ISU SSTEP graduates’ habits is not known. These factors may confound the data, but may also underscore important factors that explain the results. Additional confounding factors will be considered in Chapter 5.

Finally, one additional limitation of the study arises from the fact that the primary researcher in this study has a unique combination of background experiences, formal education, biases, and understanding of effective instruction that will differ from raters of other researchers. Results and interpretations made in this study may be influenced by these prior experiences, understandings, and biases. To diminish the effects of this limitation the rater has carefully laid out sufficient evidence to support the ratings assigned. This limitation is further diminished because some teachers were observed by multiple researchers. The researchers then met and discussed their findings, and similar conclusions had been drawn. Also, some artifacts of teachers were examined by two or more researchers and discussed to confirm agreement in interpretation between researchers.
CHAPTER 4: RESULTS AND ANALYSIS

Summary of Study

The goal of this study is to examine six graduates of the ISU SSTEP and determine to what extent their understanding and habits align with the program from which they graduated. These findings will be shared with Iowa State University science education faculty, along with the research of other graduate students, in order to assess the current state of the ISU SSTEP. The knowledge gained through this study may also be generalized to other science education programs.

Review of Research Questions

The research questions of this study fit within two broad 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 ISU SSTEP Graduates:
   a. What habits of 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 the ISU SSTEP?

Answering these questions will help guide the future direction of the ISU SSTEP. This study does not evaluate nor make judgments on the effectiveness of any individual’s science teaching practice. It also does not attempt to assess the impact of either program on the
science achievement of secondary students. This present study is a contribution towards these overarching goals to improve the preparation of science teachers. This chapter includes a description of each of the ISU SSTEPs, case analyses for each of the six study participants, and a discussion of finding related to the two research questions.

**Former and Current ISU SSTEP**

**Former ISU SSTEP Licensure Requirements (Spring 2000 to Spring 2003)**

During the spring 2000 semester a one-semester course was required. The class met once per week for three-hours for the duration of the semester. The courses and requirements for this licensure program appear in Table 2.

<table>
<thead>
<tr>
<th>Required courses and credits (cr) of the former ISU SSTEP Licensure Program</th>
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<tbody>
<tr>
<td>Instructional Technology (3 cr)</td>
</tr>
<tr>
<td>Social Foundations of American Education (3 cr)</td>
</tr>
<tr>
<td>Educational Psychology (3 cr)</td>
</tr>
<tr>
<td>Multicultural Education (3 cr)</td>
</tr>
<tr>
<td>Principles of Secondary Education (3 cr)</td>
</tr>
<tr>
<td>Education of the Exceptional Learner in a Diverse Society (3 cr)</td>
</tr>
<tr>
<td>Secondary Science Methods (3 cr)</td>
</tr>
<tr>
<td>Pre-Student Teaching Field Experience (minimum of 50 clock hours/3 cr)</td>
</tr>
<tr>
<td>Student Teaching (12 cr)</td>
</tr>
</tbody>
</table>

36 credits total

**Current Undergraduate ISU SSTEP Licensure Requirements**

Further refinements were made to the undergraduate science methods requirements. Beginning in the spring semester of 2003, undergraduates were required to take a three-course sequence of science methods. A summary of the courses and requirements under the current ISU SSTEP appears in Table 3.

The modified program included several additional requirements over the previous one-semester science methods program. For instance, the original General Field Experience
Table 3. Required courses and credits (cr) of the current undergraduate ISU SSTEP Licensure Program

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Undergraduate ISU SSTEP:</td>
<td></td>
</tr>
<tr>
<td>Instructional Technology</td>
<td>3 cr</td>
</tr>
<tr>
<td>Social Foundations of American Education</td>
<td>3 cr</td>
</tr>
<tr>
<td>Educational Psychology</td>
<td>3 cr</td>
</tr>
<tr>
<td>Multicultural Education</td>
<td>3 cr</td>
</tr>
<tr>
<td>Introduction to Science Teaching</td>
<td>1 cr</td>
</tr>
<tr>
<td>Education of the Exceptional Learner in a Diverse Society</td>
<td>3 cr</td>
</tr>
<tr>
<td>Secondary Science Methods I</td>
<td>2 cr</td>
</tr>
<tr>
<td>Secondary Science Methods II</td>
<td>2 cr</td>
</tr>
<tr>
<td>Nature of Science and Science Education</td>
<td>3 cr</td>
</tr>
<tr>
<td>Pre-Student Teaching Field Experience</td>
<td></td>
</tr>
<tr>
<td>(minimum of 100 clock hours/5 cr)</td>
<td></td>
</tr>
<tr>
<td>Student Teaching</td>
<td>12 cr</td>
</tr>
</tbody>
</table>

40 credits total

course included relatively little assistance which specifically targeted science education. The faculty supervisor was responsible for students from all content backgrounds. A new Introduction to Science Teaching section was opened that was supervised by a member of the science education faculty. This new section includes both a university classroom setting and practicum component. The on-campus component requires students to address current problems in science education, generate a set of goals for their future students, and engage in peer-to-peer discussions about how people learn.

During the following semester students take Secondary Science Methods I. This course is a continuation of the Introduction to Science Teaching course, and expands significantly on investigating how people learn. Additionally, a comprehensive, research-based framework (RBF) term paper is developed that pushes students to synthesize a clear explanation of “why science should be taught, why [the student has] chosen to teach science, and how [the student] will provide evaluation of [his/her] program, students, and
[his/herself] (Clough, 2005b, p.6). The course culminates with a 1.5-hour exit interview between the instructor and each student. The interview focuses on the student’s ability to articulate important aspects of a research-based framework for teaching science, and evidenced by an understanding of the complex interactions taking place during teaching.

Following Methods I students enroll in Methods II. This course expands on the previous two courses and places added emphasis on instructional issues such as classroom management, readings in science content areas, safety in the classroom, distinguishing and modifying decisions based on the needs and diversity in students, and assessment. Students revise their RBF papers to encompass the above instructional issues and make “synergistic links that bring coherence to teacher decision-making (Clough, 2005c, p. 5).”

Students also take a Nature of Science course, which addresses the intersection of issues in the history, philosophy and psychology of science and their application to and impact on science teaching and learning, science teacher education, and science education research. While the other science teaching methods courses convey the significance of the nature of science, this course brings sharper focus to the issues listed above.

This sequence of courses is intended to carefully scaffold the targeted pedagogical components into a coherent, seamless set of experiences. The courses are modeled after education research and faculty intend to model the instructional strategies that are taught. All aspects of the experience are layered with incremental increases in complexity and demand. Students spend at least 20-hours in science classrooms during the initial field experience course, and then an additional 40- and 60-hours during Methods I and Methods II, respectively.
Iowa State Science Education M.A.T. Licensure (Spring 2003 to present)

The M.A.T. program was developed for individuals who already possess a Bachelor of Science (B.S.) degree in a science content area, and who have taken few or no courses in education. Prior to the implementation of the M.A.T. program, individuals interested in teacher licensure who possessed a science related B.S. degree would have had to take two years of course work to receive licensure, and this would not have resulted in an additional degree. Students accepted into the M.A.T. program participate in cohorts, completing the program in 15-months over a duration of four semesters beginning and ending in summer sessions. This was designed so graduates would be in a position to immediately seek teaching employment for the fall term. The course sequence is identical to the undergraduate program, except that students take a fourth science methods course in Advanced Pedagogy. In fact, most courses are dual listed for both undergraduate and graduate students. The exception is CI 514, which is the graduate equivalent to the general field experience course (CI 280M). All dual listed courses have additional graduate level requirements. The ISU SSTEP also specifies course requirements for MAT students. A summary of the courses and requirements under the current graduate ISU SSTEP appears in Table 4.

Bergman describes several ways in which the current and former programs differ:

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.
Table 4. Required courses and credits (cr) of the current graduate ISU SSTEP Licensure Program

<table>
<thead>
<tr>
<th>Current Graduate (MAT) ISU SSTEP:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Technology (3 cr)</td>
</tr>
<tr>
<td>Social Foundations of American Education (3 cr)</td>
</tr>
<tr>
<td>Educational Psychology (3 cr)</td>
</tr>
<tr>
<td>Multicultural Education (3 cr)</td>
</tr>
<tr>
<td>Introduction to Science Teaching (1 cr)</td>
</tr>
<tr>
<td>Education of the Exceptional Learner in a Diverse Society (3 cr)</td>
</tr>
<tr>
<td>Secondary Science Methods I (2 cr)</td>
</tr>
<tr>
<td>Secondary Science Methods II (2 cr)</td>
</tr>
<tr>
<td>Nature of Science and Science Education (3 cr)</td>
</tr>
<tr>
<td>Teaching Students with Disabilities (3 cr)</td>
</tr>
<tr>
<td>Masters Degree Project (3 cr)</td>
</tr>
<tr>
<td>Pre-Student Teaching Field Experience (minimum of 100 clock hours/5 cr)</td>
</tr>
<tr>
<td>Student Teaching (12 cr)</td>
</tr>
</tbody>
</table>

45 credits total

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.

**Teacher Case Analyses**

The following section is a summary and analysis of each of the teachers who participated in this study. The components of each summary and analysis align with the work of Bergman (2007) in order to fit seamlessly within the wider ISU SSTEP study. Each case analysis includes the following descriptions:

1. An overview of the teacher’s experience and school setting;
2. Content and activities used in lessons along with Classroom Observation Protocol (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 promoted and modeled in the ISU SSTEP (Bergman, 2007).

Methods used in this study for collecting and analyzing data were described in Chapter 3. Coding and tagging of data will make use of the same system used in Bergman’s study. Specifically, the goals for students section includes both the observer’s *Perceived Goals for Students* and the teachers’ self-reported goals for students. Goals marked with an asterisk (*) indicate those goals which the teacher feels is most emphasized in their teaching (as reported on the on-line questionnaire). If a self-reported goal is followed by a number in parentheses (#), this number indicates the same goal found on the student questionnaires and goal observation sheet.
Teacher F-1: 4th Year Teacher (Former Program)

Overview

Teacher F-1 is in his fourth year of teaching, and comes from the one semester methods program. He teaches both biology and anatomy & physiology at a high school in a suburban, middle-class school. Prior to teaching Teacher F-1 worked in a number of professional fields, including computer sales for 9-10 years, medical sales for 7 years, and hospital architectural design work for 3 years. Upon leaving the architectural design company, he entered the ISU SSTEP program and completed his licensure requirements.

Entering Teacher F-1’s classroom for the first time gives the immediate impression that students are mentally engaged and enthusiastic. The walls are teeming with posters, models, and student work. Students come up to the teacher prior to the bell to ask questions about a project in progress. Students are talking to each other about group work. A few seconds before the bell rings students under their own initiative take a seat at their desks.

Content, Activities, COP Coding

When the bell rang to start the class period, Teacher F-1 immediately gained students’ attention. He initiated the class by having students take out a sheet of paper and write three things that they knew about a particular science topic. Students quickly began writing down their answers, giving the impression that they are accustomed to this sort of activity. Teacher F-1 walked around the room and looked at students’ papers. This initial task led into a discussion regarding the purpose of science, leading eventually into an activity in which students predicted and created a futuristic animal that had evolved over a long stretch of time. Teacher F-1 had a strong rapport with his students, and students were quick to raise their hands to answer his questions. He was aware of all students in the class, on some occasions
selecting students who raised their hands, but at other times pulling in students who may have been trying to be passive. These actions of beginning class promptly after the bell rings, engaging students with questions, and involving as many students as possible are all promoted in the ISU SSTEP.

Teacher F-1 appeared to be very reflective in front of students, making use of wait-time to draw out students’ thinking and responding, and generating probing questions to push students deeper into thought. He also used students’ responses to open new questions and lines of discussion. Once students began the activity, Teacher F-1 stood to the side of the room to ensure students were working, and after a few minutes began moving his way from student to student, asking questions that provided students with ideas to consider. Students used the entire class period to work on the activity. The clear expectations, high student involvement, and teacher contact resulted in high ratings across the categories in the COP coding (Figure 2).

**Teacher Behaviors and SATIC Pattern**

Teacher F-1’s energetic tone has a positive impact on getting students’ attention, however tone alone is insufficient in holding their attention. Teacher F-1 also has a high level of awareness of all students in his class, and actively pulls as many in as possible.

**Questioning:** Teacher F-1 used a wide variety of questions during the initial class discussion. He made use of some short-answer questions (SATIC 3b, e.g. “What will replace us?”), constituting three out of the seven questions posed. While these questions are appropriate in some contexts, the ISU SSTEP works with preservice teachers to develop a habit of action of posing open-ended questions. Teacher F-1 included thought-provoking short-answer questions (SATIC 3c), such as “What is the purpose of science?” This question
was used to guide students into thinking about their strategy for the upcoming activity. One instance where Teacher F-1 short circuited his questioning was when he posed a thought-provoking question, but then immediately rephrased the question as a yes/no question (SATIC 3a). The resulting quality of responses from students was much lower that it might have been if he had hung onto the original question. Overall, the questioning patterns promoted by the ISU SSTEP are strongly exhibited by Teacher F-1.

**Responding:** Student-centered responses such as asking for elaboration (SATIC 11; 2 incidents) accounted for only 12.5% of all responses. Teacher F-1 neutrally acknowledged student comments (SATIC 6) once, and the remaining responses were teacher-centered, including rejecting (SATIC 8; 1 incident); confirming (SATIC 7; 1 incident); repeating (SATIC 8; 7 incidents); clarifying (SATIC 9; 1 incident); and answer (SATIC 10; 2

*Maximum Capsule rating is 8; all other categories have a maximum rating of 5*
incidents) students’ comments. The high incidence of repeating students’ responses was used to ensure all students heard the responses, but can have the unintended effect of conditioning students to stop listening to other students, and instead listen only to what the teacher says. Some response patterns that are modeled in the ISU SSTEP appear to have transferred into Teacher F-1’s teaching practice. Other patterns, such as the high frequency of repeating students’ responses, is a low match to the ISU SSTEP.

**Non-verbal Behaviors:** Teacher F-1 is energetic in a way that draws most students in. He is an attentive listener and maintains a high level of eye contact. He also moved about the classroom during both the class discussion and the animal evolution activity. When working with an individual or group, Teacher F-1 pivoted his stance so that he was positioned to see the rest of the class. These behaviors are advocated by the ISU SSTEP as ways to encourage student thinking.

**Perceived Goals for Students**

In the on-line questionnaire, Teacher F-1 reported seven goals for students, all which are specified as highly emphasized:

a) Students will use critical thinking skills (#2)
b) Students will use metacognition
c) Students will understand how to learn rather than what to learn
d) Students will understand scientific and biological concepts (#11)
e) Students will understand cause and effect (hypothetical situations)

Teacher F-1 had students take the goal questionnaire (*Figure 3*). Only one goal had a rating below “much” emphasis in the classroom. This was Goal #6: Students will actively participate in working toward solutions to local, national, and global problems (mean = 3.82, SD = 0.84). The two goals scoring the highest average ratings are Goal #2: Students will use critical thinking skills (mean = 4.78, SD = 0.46), and Goal #3: Students will convey an
understanding of what science is, what real scientists are like, and how science really works (mean = 4.69, SD = 0.51). The student responses are consistent with other data collected from observations, artifacts, and interviews.

![Bar chart showing student goals questionnaire results for Teacher F-1 (N = 51)](image.png)

**Figure 3:** Student goals questionnaire results for Teacher F-1 (N = 51)

**Interview**

Teacher F-1 placed little emphasis on the value of his research-based framework in his current teaching. When asked about courses and specific components of courses that were beneficial or significant, no mention was made of the research-based framework. When reminded of the paper, he stated that he thought it was a significant assignment of the course, but not of strong value to his teaching.

At that point in time I was getting tired. I think you’re in a mixed situation. You’ve been doing the class for about a year and a half; you’re looking at doing your student teaching. And now you’ve got this paper that I think most of the students did in a rote method. They were attempting to get it completed, not necessarily attempting to consider it as a tool to be used later.
Teacher F-1 also felt there was a struggle within the class to see the rationale for writing the research-based framework paper.

I think the reflection paper was one of those things where it was a little bit of a struggle in getting everyone on the same page. And I think that in our group there may have even been some confusion about the purpose of it. You know, what are we going to walk out of here with? Is it an evaluation tool? Is it a teaching tool? Is it an exercise in group dynamics? And I think that as a result it may not have been as valuable as it was hoped to be.

The value of the research-based framework emphasized by the ISU SSTEP did not appear to transfer to Teacher F-1’s understanding, although his actions align well with those promoted by the ISU SSTEP.

Teacher F-1 struggled to identify other items from the ISU SSTEP that guide his current teaching, such as the SATIC self-assessment tool, the development of goals for students, and the oral defense. The two activities that he recalled included an evolution professor’s use of a term paper as an assessment, and an M&M activity demonstrated by the methods instructor. When discussing the importance of goals, Teacher F-1 explained that:

Developing the goals was important because it really got back to the cornerstone of why people go into teaching.

Interestingly, Teacher F-1 provided a list of five goals for students on his on-line survey. He also gave limited explanations of his role in planning and implementing effective instruction. In most cases his responses were focused on what he wanted students to do, without mention of what the teacher does. For example, when asked how the teacher works to create meaningful discussions, he stated:

It all starts at the beginning of the course where you start right away with the concept that questions are good. That asking questions is the most critical component of it. And very quickly people would realize how easy it is to get off track. And rather than being upset with them for getting my off topic I would say that is what you should be
doing. You should constantly be looking at going in different directions, because that is where you are going to learn.

It appears the ISU SSTEP’s emphasis on continual self-assessment did not transfer well into Teacher F-1’s habit of reflection and improving practice. For example, Teacher F-1 spent considerable time planning meaningful activities and assessments, while less emphasis was placed on evaluating his questioning patterns. This was evidenced by three out of seven of his initiatory questions having a rating of SATIC 3a or 3b, and instances of double questions, which tend to lower the length and depth of student responses.

**Artifacts**

Analysis of artifacts provided by Teacher F-1 was insightful. Teacher F-1’s classes often used investigative labs to study science concepts. One activity was used to determine the significance of the ratio between surface area and volume of cells. The lab was very directive—students were required to follow detailed instructions. In order to achieve the desired results, and in order to maintain safety, some steps had to be carefully orchestrated. However, students had very little involvement in designing or implementing the activity. The activity included a data table, which limits students’ problem solving and development of organization skills. The analysis section of the activity included a list of questions addressing interpreting results, drawing conclusions, explaining the significance of certain steps, and lab safety. In this instance the ISU SSTEP’s endorsement of modifying activities to promote student goals did not transfer into Teacher F-1’s practice to the desired extent.

In another activity students are challenged to choose either a dog or cat, then draw and describe how they think it would evolve over a long stretch of time. Students are given general guidelines about what criteria they must meet, but much of the decisions are left to
students. Such an activity fosters many student goals such as creativity, effective communication, and critical thinking.

One of Teacher F-1’s artifacts included an assessment with 17 questions. Three questions were true/false, and nine were multiple choice. Such questions tend to limit students’ critical thinking, creativity, and deep content understanding. The remaining five items were short answer questions, which sought basic definitions and simple comparing and contrasting. The ISU SSTEP advocates developing summative assessments that include items that measure students’ conceptual understanding and ability to problem-solve, think critically, and clearly communicate their thinking. This assessment emphasis did not transfer well from the ISU SSTEP to Teacher F-1’s practice of student assessment.

Summary

**Habits of Understanding:** Teacher F-1 explained that a research-based foundation plays a nominal role in informing his decision-making as a teacher. This indicates the ISU SSTEP’s emphasis on a research-based framework did not transfer into his understanding. In his interview he alluded to strategies to meet students’ needs and promote learning. He also identified strategies for encouraging student goals such as critical thinking. While these are positive indicators, he also placed minor emphasis on the value of self-assessing his own teaching practices and behaviors. These behaviors exhibit a moderate (M) rating to habits of understanding promoted by the ISU SSTEP.

**Habits of Action:** Teacher F-1 scored a moderate (M) match to the ISU SSTEP. Lessons and activities analyzed through observations and artifacts revealed a strong effort to promote student goals such as critical thinking, use communication effectively, and be creative and/or curious. However, some activities limited student decision-making in ways
that could easily be modified to promote such skills. Also, the number of simple questions
(SATIC 3a, 3b) was nearly equal to the number of open-ended questions (SATIC 3c, 4) and
teacher-centered responses were common.

**Habits of Reflection:** Teacher F-1 exhibited habits of reflection that have a moderate
(M) match to the ISU SSTEP. The interview revealed Teacher F-1’s desire for students to
investigate answers to their questions rather than relying on the teacher for answers. Teacher
F-1 relates this desire to his goals of critical thinking and understanding how to learn rather
than what to learn. However, the ISU SSTEP’s emphasis on student-centered questioning
strategies displayed a moderate transfer into his teaching practice.

**Habits of Improving Practice:** Teacher F-1 specified no action plan for improving
his practice. When asked in what ways he could improve his teaching, he specified ways that
students could better attain student goals. Teacher F-1 indicated a desire to have colleagues
or administrators visit his classroom, but this was not in the context of seeking feedback of
his teaching practices. These indicators reflect a moderate (M) match to the habits of
improving practice advocated by the ISU SSTEP.

**Overall Alignment of Habits with the ISU SSTEP:** Teacher F-1 implemented
activities that are highly reflective of the National Science Education Standards. This is
evidenced by activities that had a clear purpose and goal, encouraged public discussion of
ideas, and encouraged students to generate ideas, questions, conjectures, and propositions.
However some habits do not strongly align with the ISU SSTEP, as described in each of the
summaries above. These indicators result in an overall moderate (M) match between his
habits and those of the ISU SSTEP.
Teacher F-2: 5th Year Teacher (Former Program)

Overview

Teacher F-2 is the biology and advanced biology teacher at a small school located in a rural community. The biology classes observed consisted of around twenty students. The classroom is part of a new addition to the building, built specifically as a science room. The largest portion of the classroom is a large, rectangular open space with long tables for student seating. The tables are arranged lengthwise to allow all students to face the front of the classroom, where there is a wide dry erase board. The front of the room has a teacher desk and a spacious lab demonstration bench. To the side of the room are four large round stationary lab tables with computer consoles and open desk space. Students can easily move from their regular seating area to the lab, and since the two area are joined, the class can be split between the two areas while maintaining teacher supervision.

The classroom had a laid back, yet purposeful atmosphere. Students were well-behaved, attentive, and responsive to the direction of the teacher. Many students contributed to classroom discussions, and quickly delved into lab activities. Students asked questions when needed, and worked with partners to complete activities.

Content, Activities, COP Coding

Teacher F-2 displays well organized instruction, and is welcoming in his interactions with students. During the first observation students were seated in the main part of the classroom at the sound of the bell, and Teacher F-2 immediately started the class period with a question. As students raised theirs hands, Teacher F-2 called on students and wrote their responses on the board. This discussion pulled from a reading that students has recently completed, and was an effort to draw out key points. The discussion moved toward a list of
statements regarding population dynamics. Students were already familiar with the list from previous work, and Teacher F-2 wrote them out on the board one by one. After writing the each statement, Teacher F-2 posed open-ended questions, probed students’ responses, and had students come to the board to draw graphs to explain their answers. Students were attentive and there was no noticeable off-task behavior. Throughout the observations, Teacher F-2 displayed a scaffold approach of instruction, using both the main room and lab area to create exploratory activities, and then using discussion to consolidate ideas. For example, during an activity in which students were developing a method for collective data about variation in length of dandelions, Teacher F-2 stopped the class to discuss a problem that one group had encountered. Teacher F-2 often used the outcomes of students’ work to generate questions for the class to contemplate. These observations led to high COP ratings (Figure 4).

Teacher Behaviors and SATIC Pattern

Teacher F-2 displayed several questioning patterns promoted by the ISU SSTEP, including the extensive use of initiating with thought-provoking (SATIC 3c) and extended-answer questions (SATIC 4), and asking students to clarify or elaborate and using students question (SATIC 11) or ideas (SATIC 12). However, he also at times did not use wait time, which the ISU SSTEP states has a tendency to stifle student thinking when not used.

Questioning: Teacher F-2 displayed a questioning pattern consistent with what is modeled in the ISU SSTEP. 76% of his questions were thought-provoking short-answer questions (SATIC 3c), with another 15% being extended-answer questions (SATIC 4). For example, during a discussion the statement ‘Population increases exponentially if all offspring survive’ was written on the board. Teacher F-2 turned to the class and asked,
“What might a graph of this look like if drawn?” Several students came to the board and offered various drawings, which were then compared and discussed. One questioning habit discouraged by the ISU SSTEP was observed in Teacher F-2’s teaching practice. On a number of occasions Teacher F-2 posed a double question in which one question is posed and then immediately rephrased. The ISU SSTEP teaches that this practice has a tendency to stifling students in their thinking because they often struggle to identify which question to answer.

**Responding:** Teacher F-2 had a mixture of both teacher-centered and student-centered responses to student comments and questions. After almost every student response, Teacher F-2 would repeat the students comment (SATIC 8; 12 incidents). This accounts for
52% of his responses. The frequency of repeating students’ responses is identified by the ISU SSTEP as an annoying mannerism (SATiC 15), as it can limit student involvement if they listen only to what the teacher says, and not what other students say. There was evidence of this undesirable effect when one student had to ask a classmate to repeat their response because he had not paid attention. In most other cases Teacher F-2 would ask for the student to clarify or elaborate (SATiC 11; 7 incidents). This responding technique is advocated in the ISU SSTEP as a way to encourage deeper thinking.

**Non-verbal Behaviors:** As mentioned above, the overuse of repeating students’ responses could be perceived by students as an annoying mannerism. Teacher F-2 often made extensive use of wait time, which is to pause for several seconds after his questions and after student responses to encourage thinking and increase participation. Teacher F-2 has a very calm disposition, and his body language was open and relaxed. During most discussions he limited his movement to the area by the chalkboard, which was apparently due to wanting to work through a set of statements that had been previously generated in class.

**Perceived Goals for Students**

In the on-line questionnaire, Teacher F-2 did not report any goals he has for students. However, he did provide during the interview a list of ten goals that he promotes in his classroom. These goals include:

a) Students will think critically and creatively. (#2, #7)
b) Students will demonstrate an understanding of the nature of science. (#3)
c) Students will encourage, respect, teach, and learn from each other.
d) Students will contribute to class by asking questions and sharing their perspectives. (#5)
e) Students will appreciate and enjoy the complexity of science. (#11)
f) Students will take pride in their accomplishments. (#1)
g) Students will make connections between science, world, and other disciplines.
h) Students will make mistakes and use that opportunity to learn from them.
i) Students will challenge themselves to achieve, understand, and apply science. (#10)

j) Students will exhibit a deep understanding of the concepts in science content including the application of the scientific process. (#11)

Teacher F-2 had students take the goal questionnaire (Figure 5). The two goals with the lowest ranking were Goal #6: Students will actively participate in working toward solutions to local, national, and global problems (mean = 3.65, SD = 1.00) and Goal #12: Students will demonstrate an awareness of the importance of science in many careers (mean = 3.78, SD = 0.91). The student responses are consistent with other data collected from observations, artifacts, and interviews.

![Figure 5: Student goals questionnaire results for Teacher F-2 (N = 78)](image)

**Interview**

Teacher F-2 explained that several components of the ISU SSTEP were significant in preparing him to teach science. For example, the set of student goals developed in the methods course is an important part of his teaching.
The goals really give me something concrete, something that I know that I’m working towards. Some of these goals go beyond science literacy, they go into problem solving and critical thinking. At the end of the year I usually have students do a survey where they have evaluate how well they think they have progressed in each of the goal areas. [The goals] are the things that I expect them to be able to do at the end of the year, not things like Punnett squares.

Teacher F-2 described the development of his student goals as a component of the RBF.

Both the RBF and his student goals have remained a central part of his classroom.

The basic skeleton of [the RBF], like my classroom set up and how I’m going to achieve my goals; Many of those things are still pretty similar. There are some minor things that have changed, but the major things like the way I’m going to arrange my classroom, the way I’m going to treat students in my classroom; Those things have all stayed pretty constant. As the content changed, those goals all stayed the same.

Teacher F-2 discussed teacher behaviors that he deems important in promoting his student goals during classroom activities.

There are a lot of teacher actions that you can go through to get [achieve these goals]. For myself, its always showing them my excitement for what we’re doing, being positive with them, being assertive on what I want, being direct. And then using all those other things, the wait time, the non-verbals. All those things the reinforce the idea that you want their involvement, you want their response, that its not just about the teacher. Its about them getting involved, and using that consistently so that they know and expect it.

Teacher F-2 exhibits a deep level of reflection of his practices. He points to characteristics of an effective teacher that are indispensable.

Without the ability to form good questions I don’t know how you could be successful as an inquiry based teacher. The question skills really determine how effective your lab is going to be, how effective your discussions are going to be. Otherwise you turn into just a presenter of information, and I don’t want that. That’s the very traditional science teacher, and that’s never what I’ve wanted since I got out of methods. So I think those questioning skills are the backbone of effective development of lessons, communication of ideas, development of knowledge within the students. It’s probably one of the most important skills for a science teacher, or any teacher.
Teacher F-2 has a developed picture of effective teaching, however also knows that moving toward this ideal does not come through experience alone. When asked how improvement in questioning is attained, he responded:

   Honestly, I think for me I need to get into the [university] classroom in terms of being a student again. I haven’t taken any classes at Iowa State since I graduated… and being away from it for this long I feel like I’m starting to plateau and I need to push myself a little further.

Teacher F-2 shared other ideas that demonstrate a thoughtful reflection of his teacher practices and desire to steadily become a more effective teacher. The strong emphasis on reflection modeled in the ISU SSTEP is evident in Teacher F-2’s actions.

**Artifacts**

Teacher F-2’s materials complement the student-centered instruction previously described. Students were assigned an activity which entailed running a software program to simulate variations in populations. Each student was given a four page packet to accompany the activity. Students were given instructions on how to access the program and basic directions describing the simulation. Aside from this, students were responsible for determining how to use the program to gather meaning data and interpreting it. For example, the instructions state “You are responsible for recording all of the necessary information, and drawing conclusions about what you think is happening. This also means that you have to determine how long you think the simulations should run.”

   The packet provided limited space for recording data, implying that students would need to find another place to organize data. The majority of the remainder of the packet contained questions for students to answer pertaining to the simulation. These questions
often required students to think back to previous activities. Examples of these questions include:

- How does this relate back to the M&M activity?
- How do populations like the guppies illustrate the basic idea of survival of the fittest?

Teacher F-2 also provided sets of lesson plans. Teacher F-2 wrote out teacher behaviors that he labeled as important to promote student achievement. For example,

> During the lab it is important to circulate among the students and ask questions, providing them with the materials that they ask for and to remain as impartial to the results as possible, while still leading them in the “correct” direction. This may mean that asking questions like “What does weighing the beaker mean to the weight of the reactions.

Other artifacts highlighted examples of questions that could be used during the activity, ways to consolidate ideas based upon data collected by students, and clear student objectives achieved through completing the lesson.

**Summary**

**Habits of Understanding:** Teacher F-2’s interview responses led to a rating of his habits of understanding that is a high (H) match to the ISU SSTEP. In articulating his responses he continually related his teaching decisions to the research-supported framework he had developed while in the ISU SSTEP.

**Habits of Action:** Teacher F-2 has a high (H) match to the habits of action promoted by the ISU SSTEP. This is evidenced by his actions that are modeled in the ISU SSTEP, such as thoughtful lesson planning, careful implementation combined with inquiry strategies, student discussions, and questioning patterns that emphasize thought-provoking questions combined with effective wait time within a supportive classroom environment.
**Habits of Reflection:** As described in previous sections, Teacher F-2 exhibits a deep level of reflection. Teacher F-2 uses his student goals as the cornerstone by which all other aspects of teaching are built. He refers to both the theoretical foundations of pedagogy learned from the ISU SSTEP and his past experiences to guide decisions on how to design and effectively implement classroom activities, discussions, and assessments. All of these behaviors align with a high (H) match to the self-reflective habits promoted by the ISU SSTEP.

**Habits of Improving Practice:** Teacher F-2 is best described as a high (H) match to the ISU SSTEP with respect to habits of improving practice. In the interview he provided a balanced self-assessment of his current teaching practices. For the weaknesses he perceives he described specific actions to pursue improvement, such as seeking assistance through additional graduate level courses.

**Overall Alignment of Habits with the ISU SSTEP:** The ratings above lead to a high (H) match between Teacher F-2’s overall habits and the ISU SSTEP. His understanding of the complex nature of learning and teaching guide him as he works to design and implement effective instruction. Teacher F-2 knows that his improvement will not come through experience alone, but through continual self-assessment and enthusiastic energy.

**Teacher F-3: 3rd Year Teacher (Former Program)**

**Overview**

Teacher F-3 is the 8th grade science teacher at a small rural school. The classes observed consisted of 19-23 students. Teacher F-3 is in his third year of teaching, and struggles to create an effective learning environment. While the classroom environment is friendly and the teacher is well liked by students, classroom content is limited to science
trivia and memorization. Activities have a busy feel, but do not target a deep understanding of content.

**Content, Activities, COP Coding**

During one observation, students were reviewing for an upcoming test. Students had been given a review guide the day before, and on this day they worked through the guide together. Students sat at their assigned seats around lab benches, and Teacher F-3 sat at the front of the room at a lab demonstration table. The class began with a review of predicting crosses based upon Mendelian genetics. Teacher F-3 started by having a student come to the front and draw a blank Punnett square consisting of a large square divided into four smaller equally sized squares. The class chose an organism to use for their example, and Teacher F-3 asked, “Do you want it to be homozygous or heterozygous?” A student quickly shouted out “heterozygous,” at which point Teacher F-3 responded back to the class, “Ok, so put a big “R” here and a little “r” here.” After filling in the Punnett square with letters, Teacher F-3 asked, “What is heterozygous?” Peering quickly across the classroom Teacher F-3 saw no immediate responses. Waiting perhaps two seconds, he then asked, “Is it when you have two of the same letter or different?”

The design and implementation of the review up to this point differed in a number of ways from the strategies promoted by the ISU SSTEP. First, students were limited in their involvement with the discussion, and student cognitive demand was low. Many students were not paying attention, or passively listening to the teacher. Students were not required to answer questions, as Teacher F-3 was moving at a pace that was difficult for students to follow. In contrast, the ISU SSTEP promoted and modeled strategies in formative assessment, such as using probing questions that require students to respond beyond a recall
of trivial facts. ISU SSTEP also promoted and modeled asking students to elaborate upon answers, and using student ideas in further questioning to help students come to see how ideas play out. None of this was apparent in the observed lesson.

A few minutes later Teacher F-3 turned to a list of review questions that have been handed out the students the previous day. Teacher F-3 would read a question and randomly call on a student for their answer. Many students did not complete the assignment, because when called upon they would say that they “didn’t figure that one out,” at which point Teacher F-3 would go to another student. After a few minutes of calling on students, Teacher F-3 had identified which students completed the assignment, and in most cases called only on those students. The pace of the question and answering was so fast that many students had time only to quickly scribbled down part of an answer before the class had moved on to the next question.

The two other observations were also review days, in which students played games to review for a test. One game was a form of bingo in which students created a five by five grid and wrote in one or two word answers from a pool of possible answers. Teacher F-3 then read a question, and if students thought the answer was found on their board, they would place a marker on that spot. When a student scored a bingo, they would read off their line of answers to see if they had answered the questions correctly. Questions were limited primarily to terminology in order to accommodate the bingo boards. The second review game divided the class into two groups. A member from each group stood next to each other with several feet between them and the teacher’s desk. Teacher F-3 read a question, and then students raced to the desk to grab a toy, earning them the right to answer the question. Correct answers earned points for the team, incorrect answers gave the other team the
opportunity to steal points. Again, the activity limited itself to low level questioning with no follow up questions to delve to any depth of understanding.

Based upon the low quality of these activities, the COP ratings were low across all categories (Figure 6).

![Figure 6: COP coding for Teacher F-3](image)

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

Teacher Behaviors and SATIC Pattern

During his interactions with students, Teacher F-3 typically asked SATIC 3b questions requesting the recall of definitions and names. Students appeared to be accustomed to what took place in the observed instruction. The ISU SSTEP promotes and models open-ended, thought-provoking questions, but this habit was not observed in Teacher F-3’s habit of action.
**Questioning:** Teacher F-3 almost always used low quality initiatory questions. Of the nineteen questions posed, only one was coded as a thought-provoking short-answer question (SATIC 3c), and all others were either dichotomous (SATIC 3a) or short-answer (SATIC 3b). Accompanying the low quality questioning was the habit of rarely asking a student to elaborate on their answer. It may have been difficult to have a student go any deeper in their thinking when the initiatory question was low level.

**Responding:** Teacher F-3’s responding was almost always teacher-centered. In most cases he either confirmed or praised the comment (SATIC 7; 31% of responses), repeated the comment (SATIC 8; 38% of responses), or clarified or interpreted the comment (SATIC 9; 24%). These teacher-centered responses accounted for 93% of all responses.

**Non-verbal Behaviors:** During one observation Teacher F-3 exhibited two instances of inappropriate wait-time I, which is the recommended 3-5 second pause to provide students time to think after posing a question. In most other incidents he made good eye contact with students, and presented positive, facial gestures to encourage participation. On the other hand, Teacher F-3 spent the majority of the time sitting at the teacher demonstration lab bench reading questions while students either sat and answered, or moved around during a review game.

**Perceived Goals for Students**

On the on-line questionnaire, Teacher F-3 listed 12 goals he currently has for his students:

a) *Students will work well with others and independently  
b) *Students will exhibit confidence (#1)  
c) Students will make and apply connections between science and their lives  
d) Students will identify and attempt to problem solve (#4)  
e) *Students will show an appreciation and genuine interest in science
f) Students will be a self-motivated, life long learner

g) Students will exhibit critical and logical thinking skills (#2)

h) *Students will exhibit a robust understanding of fundamental science ideas (#11)

i) Students will show an understanding of the nature of science (#3)

j) Students will enhance and expand their thinking skills (#2)

k) Students will respect themselves and others

l) *Students will exhibit creativity in thinking (#7)

Teacher F-3 was given the student questionnaire, however he opted to not distribute it to any of his classes. Other data sources and observations speak to these goals. Students felt comfortable in the classroom, evidenced by an openness to share ideas and work with each other to complete group tasks. Students were accustomed to a generally laid back environment, and humor and light sarcasm were appreciated. These observations point toward the promotion of goals (a), (b), and (k). At the same time, other goals were not promoted due to the low expectations. Students were given few opportunities to problem solve (d), use critical thinking skills (g), or enhance and expand their thinking skills (j). It is also unlikely that students learned much science content or how science works, promoted through goals (c), (e), (h), and (i).

Interview

The interview was insightful in revealing Teacher F-3’s beliefs about effective teaching. Teacher F-3 emphasized the importance of the process of developing student goals during his methods class.

I thought [developing student goals] was very useful. I look back at those goals several times during the [school] year, whenever we’re forming units, even if its something simple like a one-day activity. I really thought, [it wasn’t] just coming up with the goals, but the discussions in the [methods] class, even if it took five classes to do it. The discussions and working to get those goals was also helpful.

Teacher F-3 also explained why the student goals are important in his classroom.
[Student goals] are important because you need to know what you’re trying to do. Are you trying to just keep them busy for 42 minutes or are you trying to really challenge them for all 42 minutes? If you don’t have the goals written down and [put some place] where you can see them, then you’ll lose track of what you’re trying to do. If you don’t have the goals sitting there, if you’re not thinking about them, then you’re going to lose track of what you ultimately want to accomplish. So you’ll start to lead students in ways that you know aren’t very productive. You’ll forget about asking questions, you’ll forget about doing good activities, you’ll forget about communicating with students.

However, as described in the sections above on Teacher Behaviors and SATIC Coding and Artifacts below there is incongruence between Teacher F-3’s stated goals and decision-making concerning content and student activities.

Teacher F-3 stated some teacher behaviors that reflect a habit of understanding matching the ISU SSTEP. He described examples of verbal and non-verbal teacher behaviors that influence students.

The inflexion of your voice; if you lean backwards against the chalkboard [students] will think [what you’re doing] doesn’t really matter; [When] they give answers, if you number them off on your fingers so that they know that you’re expecting more than that one answer. It could be just your eyes; having your eyebrows raised up. Leaning forward instead of just slouching back. Make them think that you’re looking forward to what they’re going to say.

However, Teacher F-3 also holds views that contrast with his habits of understanding promoted by the ISU SSTEP. For example, on the online questionnaire he states, “I do not use my research-based framework in my teaching. I found a difference between research and the unique situations of my students and the interactions in class.” During the final interview Teacher F-3 explained the following about preparing a lesson:

Hopefully you have a lesson thought out well enough that it doesn’t take too much to get into it. Hopefully you know; You have it set out in [written form]. You have the questions you want to ask. You have the order you want to ask them. Do you want to hand out the materials and then explain them, or do you want to explain what to do and then hand out the materials. So once you really get into it then hopefully you are following the lesson that was thought out well enough in advance.

The notion put forward here by Teacher F-3 is that a teacher can ensure effective instruction through proper planning alone. This idea is in contrast to the ISU SSTEP, which states that
lesson plans often must have built-in flexibility to accommodate students’ prior knowledge, current ideas, questions, and other unique needs. The classroom environment is constantly changing, and the teacher must continually make decisions on the spot as a result of these changes.

Teacher F-3 listed a number of behaviors promoted by the ISU SSTEP, such as questioning skills and the verbal and non-verbal teacher behaviors quoted above. When asked how he works to improve his own use teaching skills, Teacher F-3 found it difficult to explain specific examples of ways to improve his practice. For instance, when asked what accounted for his improved questioning skills he responded:

They get better every time you do something. The first year to the second year you get better. But even first period to second period you get better because every time you ask a question and you don’t get the response you were hoping for, then hopefully you take the time to evaluate it, and then next time, whether next year or next class period, you have changed. Maybe it’s something simple like only having to change your body language. Maybe the question itself was good, but you didn’t have very good body language. So next period you could ask the same question and use different body language and then you get the answer you wanted.

Teacher F-3 believes experience is a determining factor for improvement. ISU SSTEP, on the other hand, emphasized that experience alone rarely leads to highly effective teaching. Teacher F-3 did allude to the need for reflection, but struggled to explain how to evaluate his questioning. When asked further about improving his teaching, his response again did not reflect the precision and clarity promoted and modeled in the ISU SSTEP:

[It takes] a lot of self-reflection. It can be from one year to the next, or it can be from one period to the next. You can learn from within the same period. You set up an activity and you notice it isn’t going well. And within that period you can change the direction of the activity. Or you’re finished with that class and you think, “What went well? What didn’t go well?” And from one class to the next you can change what happened.
From these sorts of responses, the depth and clarity of reflection promoted and modeled by ISU SSTEP does not appear to have transferred to Teacher F-3’s practice. When asked what improvements he feels he has made in his teaching he responded in broad generalizations. 

[My teaching is] better than the year before; not as good as this year. There were things that I did last year that were better than the first two years, and there were things last year that I did better this year.

**Artifacts**

Teacher F-3 provided the study guides given to students in preparation for the upcoming tests. The guides provide evidence that support previous observations regarding his instructional practices. One study guide included a list of 29 questions that indicated they may appear on the test. All 29 items sought out science terminology. Examples include:

- “What is the name of Alfred Wegener’s theory for how the continents moved?”
- “What is the outer shell of the Earth called?”
- “What organism did Gregor Mendel work with?”
- “Tt, TT, and tt are examples of what?”

Another review guide was of the same basic format, and sought the same type of word recognition and insignificant facts. Such review material promotes only the recalling of trivial information with no emphasis on problem-solving, critical thinking, or accurate notions of the nature of science.

Exams for each of these reviews were provided. Exams placed little or no emphasis on the goals listed by Teacher F-3, such as making and applying connections between science and real life, critical thinking, exhibiting a robust understanding of fundamental science ideas, enhancing and expanding their thinking skills, and creativity. For example, the first four questions required making conversions between various units of length, weight, and volume. Students were provided with a hint that “you only have to move the decimals.”
This inhibits the goals of creativity and critical thinking skills. Many questions were either multiple choice or short-answer, and focused on basic recall of terminology. These sorts of questions also stifle many of the goals that Teacher F-3 stated were emphasized.

**Summary**

**Habits of Understanding:** Teacher F-3 lists many teacher actions and behaviors promoted by the ISU SSTEP. However, ISU SSTEP’s promoted habits of action appear not to have transferred well into this teacher’s practice. ISU SSTEP’s emphasis on copious lesson planning has transferred to Teacher F-3’s practice, but the program’s emphasis on the evolving classroom environment and fluid teacher decision-making appears not to have transferred well. This was evident during classroom observations and expressed explicitly in the final interview. The extent that Teacher F-3 does not relate teacher decisions to a research-based framework indicates a low (L) transfer of understanding from the ISU SSTEP to this teacher’s practice.

**Habits of Action:** Observations and artifacts indicate a low (L) match to the ISU SSTEP habits of action. There is a significant misalignment between Teacher F-3’s list of student goals and the actions used to promote these goals. Activities and assessments both emphasize rote memory and suppress critical thinking and problem solving.

**Habits of Reflection:** Teacher F-3 appears not to make use of a research-based framework in his decision-making. In the ISU SSTEP the research-based framework is the foundation upon which teacher decision-making and reflection is based. Thus, the habits of understanding, reflection and taking action promoted by ISU SSTEP has not transferred to any significant extent into this teacher’s practice. Teacher F-3 believes that his questioning
will naturally improve over time, an idea that was explicitly denied by the ISU SSTEP. For these reasons Teacher F-3’s habits of reflection have a low (L) match to the ISU SSTEP.

**Habits of Improving Practice:** Teacher F-3’s habits of improving practice have a low (L) match to the ISU SSTEP. When asked about areas where he could improve, Teacher F-3 had difficulty specifying areas to improve, indicating a struggle to accurately self-assess his teaching. Teacher F-3 also indicated that improvement comes through experience, a misconception explicitly addressed in the ISU SSTEP.

**Overall Alignment of Habits with the ISU SSTEP:** Overall, the habits promoted and modeled by ISU SSTEP have a low (L) transfer to Teacher F-3’s practice. His framework for effective teaching appears to be derived from sources other than the ISU SSTEP. While he identifies elements from the ISU SSTEP that he believes are important to teaching such as student goals and effective questioning, these elements have not transferred to his practice. When explaining the rationale for his teaching decisions he does not appeal to a research-based framework. While he is agreeable that self-reflection is an ingredient for improvement, he makes no reference to specific tools promoted and used in ISU SSTEP through which he might identify strengths and weaknesses in his teaching. He acknowledges that there is always room for improvement, and that experience and perseverance brings about that improvement, but the ISU SSTEP’s emphasis that these are necessary, yet insufficient, did not transfer to Teacher F-3’s practice.

**Teacher C-1: 2nd Year Teacher (Current Program)**

**Overview**

Teacher C-1 is in his second year of teaching after having graduated from the current ISU SSTEP. He teaches 11-12th Grade physics and chemistry at a high school located in a
university town of around 25,000 residents. Class sizes ranged from mid teens to low twenties. Although not a new teacher, Teacher C-1 struggles to manage student behavior and implement effective instruction. Students were allowed to talk over the teacher, interrupt discussions, and not participate. Teacher C-1 made no effort to manage these students, except through occasional sarcasm, but instead concentrated on those who chose to listen.

**Content, Activities, COP Coding**

Teacher C-1 attempted to promote a deep level of understanding of both science concepts and the nature of science, but spoke at a level well above the head’s of most students. Teacher C-1 wrote the words “charge conservation” on the board and began lecturing on its status as a science law. He attempted to interject the nature of science by explaining how this law is not provable, but most students had either lost interest or appeared to not understand what he was saying. There was little effort to involve students by posing questions, and the discussion appeared to lack direction. Soon thereafter a small number of students began asking about a physics question that did not directly related to the original topic.

In another observation, Teacher C-1 showed a short segment of a video, and then lectured. No efforts were made to involve students, such as asking questions to check understanding. Some students may have gotten something out of these activities if they could understand the lectures, while most likely learned very little, if at all. Overall, these lessons had low alignment with the NSES standards for inquiry, intellectual engagement, and collaborative interaction. Because of these teacher behaviors, the COP ratings were low to moderate (*Figure 7*).
Teacher Behaviors and SATIC Pattern

During the first observation Teacher C-1 appeared to not be bothered that many students were talking and giggling while he lectured. Interactions between the teacher and students were rare in this lesson.

**Questioning:** Teacher C-1 posed few questions to students. The ISU SSTEP emphasized that questions are an important tool to keep students engaged, encourage students to think at deeper levels, and to assess student understanding and misconceptions. Initiatory questioning typically included SATIC 3a and 3b questions. In one discussion, a total of five questions were posed. Of these, one was a yes/no question (SATIC 3a), and four were short-answer questions (SATIC 3b). The ISU SSTEP advocates initiating questions
that are thought-provoking (SATIC 3c), which is a skill that the ISU SSTEP did not transfer into Teacher C-1’s teaching practice.

**Responding:** Teacher C-1’s responding tended to be teacher-centered, as coded using the SATIC instrument. Responses included acknowledging student comment (SATIC 6; 2 incidents), repeating student comment (SATIC 8; 4 incidents), and answering student questions (SATIC 10; 3 incidents). Responses that were student-centered included two incidents of asking a student to clarify or elaborate (SATIC 11). The following is an example of a teacher student interaction:

Teacher C-1: “If I do a particle accelerator experiment, and I sum the number of electrons and anti-electrons, is this law preserved?”
Student: “Yes.”
Teacher C-1: “Yes. Now, based upon this conservation…”

The ISU SSTEP promotes the use of student-centered responses such as asking a student to clarify or elaborate (SATIC 11) or using a student’s question or idea (SATIC 12) as a way to encourage deeper thinking. The ISU SSTEP did not transfer the practice of using student-centered responses into Teacher C-1’s teaching.

**Non-verbal Behaviors:** Teacher C-1 spent most of his time sitting at the front teacher demonstration bench, getting up only occasionally to write something on the board. This form of movement likely discouraged students from focusing on the class discussion as they likely did not feel they would be confronted on their off-task behavior. Teacher C-1 also did not use wait-time after posing questions to students. The ISU SSTEP advocates using wait time as a way to increase student participation and encourage deeper thinking. This skill was not transferred from the ISU SSTEP into Teacher C-1’s teaching practice.
Perceived Goals for Students

Teacher C-1 listed 12 goals for students on the on-line questionnaire. These included the following:

a) Students will finally learn the basic skills they should have already learned by the time they reach my class.
b) *Students will understand the nature of science and how it differs from other approaches to knowing the world. (#3)
c) *Students will recognize that they are ultimately responsible for their own learning. (#8)
d) Students will be able to read.
e) *Students will have some interest in resolving discrepant information.
f) Students will how the main theories in the major fields of science and how they relate to each other.
g) *Students will demonstrate an awareness of science in the real world and its applications.
h) *Students will demonstrate critical thinking skills. (#2)
i) Students will learn how to learn
j) Students will show persistence in the face of failure and be willing to learn from their mistakes.
k) Students will exhibit integrity, responsibility, and respect.
l) Students will possess both a facility and appreciation for effective communication of ideas in the science and their lives. (#5)

Teacher C-1 was given the student questionnaire, but opted to not administer it to his classes.

Interview

Teacher C-1 expressed a deep dissatisfaction with several external factors including the lack of support from his administration and unfair expectations placed on him. He also conveyed pessimism about the current state of schooling at local and national levels. Teacher C-1 does not plan to remain in the teaching profession. One area of contention is the state mandated teacher portfolio for new teachers during their first two years of instruction.

The system by which they actually evaluate teachers is [problematic]. I’ll start by saying I taught science. One thing that we prize in the science field is that things should be objective and not subject to interpretation. [These things] should be pretty
simple to assess…In general the subject matter is quantifiable…One of the annoying things was this new system put into place by Iowa by which they evaluate teachers. What it essentially boils down to is you have to prepare a portfolio based upon something like 42 different criteria. And pretty much every one of the criteria is completely subjective.

Teacher C-1 further explained that he believes the portfolio process culminates with the decision of whether you are granted or denied a teacher license based upon whether the evaluator likes you or dislikes you. He views this practice as both unfair and unique to the teaching profession. Teacher C-1 also expressed dissatisfaction with what he perceives as a failure on the part of the administration to ensure that students retain what they learned from course to course so that it does not have to be taught again.

There was no real effort to ensure that kids had learned stuff with any kind of permanency. They really only cared if [students] passed some test. And kids knew this too. Kids would absolutely balk if you told them you had a cumulative exam because they really, truly expected because of the way every other class was, that they were expected to learn something and then forget it.

These issues and others left Teacher C-1 with what he described as a severe distaste for the current state of education. This dissatisfaction appears to have permeated Teacher C-1’s thinking to an extent that he feels that remaining in the teaching profession is not an option.

When speaking about his preparation to teach science, Teacher C-1 stated that the methods course was most instrumental in equipping him.

The things I remember [the M.A.T. program] teaching me were things about how students will have these misconceptions. And how brutally hard it is to actually get them to leave those misconceptions and adopt true scientific thinking. Most people are naturally Aristotelian thinkers. They think in terms of things slow down because…it just wants to slow down. It is Newtonian to think that it slows down because it has friction…How hard you have to work at really killing off those misconceptions. I think that was a really important thing.

I also took a lot from how we should have students find their answers. They have to get it to fit into their conceptual framework. There were a lot of ways to do that from concept maps to essays and all sorts of things that really try to get to how somebody’s
thinking fits into their world. And you have to get through to that, and this is along the lines of the misconception [discussion]. You have to reveal their misconceptions and their thinking through many different puzzles.

Teacher C-1 alluded to other components of the methods course that he thought were significant.

I would say the heavy emphasis on non-verbal gestures certainly go hand in hand with the puzzles [used to address abstract topics]. You can’t make a simple lecture interesting just by doing all the non-verbals and stuff. You have to get participation. That makes an interesting class. I’d have to say that most of the system is set up against that. What administrators like to see if kids actively doing stuff. They don’t think discussion is part of that. They like to see them fiddling with things.

Teacher C-1 did not actively use positive non-verbal gestures in his instruction. From his comments it appears that he believes it is because of a conflict with administrative protocol that he isn’t able to use this tool in ways that he feels are beneficial to students.

Teacher C-1 stated that classroom management is a common issue in most of his classes. When asked what aspects of classroom management were difficult for him, he replied:

I’ve always wanted to work out a better situation for classroom arrangement. My philosophy tends to be that if I have students who are talking… I have difficulty balancing that I like [to have] certain kids [being] able to talk with their partners and friends, if they are productive students. If they are the kind who will ask each other a question, and try to clarify it between themselves before they ask me a question. And who will actually pay attention when attention is needed, I don’t have much of a problem with them talking.

During classroom observations many students were talking with each other, and their low fast whispering gave the impression that they were not discussing science.

Artifacts

Teacher C-1 opted to not provide classroom artifacts, so analysis of the alignment of his habits to those advocated by the ISU SSTEP are based upon other data sources.
Summary

**Habits of Understanding:** Teacher C-1 conveyed that many of the core elements of the ISU SSTEP to not inform his thinking. For example, he stated that student goals are more likely to do harm that good because they set the teacher up to hold a false optimism when in fact institutional constraints will prevent the promotion of these goals. The ISU SSTEP addresses the prevalence of institutional resistance to the habits promoted by the ISU SSTEP, and offers strategies to diminish the effects of this resistance. The ISU SSTEP did not transfer this understanding to Teacher C-1. For these reasons there is a low (L) match between Teacher C-1’s habits of understanding and the ISU SSTEP.

**Habits of Action:** The ISU SSTEP model for teaching that promotes inquiry, investigation, and discussion were not observed in Teacher C-1’s instruction. For example, the ISU SSTEP encourages discussion strategies that place a greater focus on posing questions that draw out students’ thinking, generates brainstorm, and, when appropriate, emphasizes critical thinking and problem-solving. The ISU SSTEP did not transfer these habits of actions into Teacher C-1’s teaching, and therefore there exists a low (L) match between his teaching practices and the ISU SSTEP.

**Habits of Reflection:** Based upon classroom observations, the online questionnaire, and interviews, no evidence was observed that Teacher C-1 actively monitors and evaluates his own state of teaching. He does not use tools advocated by the ISU SSTEP to help identify and address areas in his teaching that may be weak. In fact, it is possible that Teacher C-1 does not perceive areas that the ISU SSTEP would identify as a weakness. Most new teachers struggle with classroom management issues, such as when students carry on conversations that are not relevant to the lesson; however Teacher C-1 seems to suggest
that this student behavior is desirable. For example, he was aware that some students were ignoring his instruction and talking, but stated that it was alright for these students to talk because they were earning a high grade. This assessment of student behavior is not consistent with the ISU SSTEP. The ISU SSTEP has not informed Teacher C-1’s habit of reflection, leading to the rating of a low (L) match with the ISU SSTEP.

**Habits of Improving Practice:** Teacher C-1 identified some weaknesses in his teaching, however did not suggest specific ways to seek improvement within this own classroom. For example, he stated that one way to improve student performance is to change schooling so that it fits the pace of the student. Also, Teacher C-1 did not recognize issues in his teaching that were specifically identified in the ISU SSTEP as common areas where teachers often struggle, and therefore should be attentive. Examples include one’s questioning techniques, wait time, positive non-verbal communication, and student on task behavior. The ISU SSTEP did not transfer these habits of improving practice to Teacher C-1. Therefore, Teacher C-1 has a low (L) match of habits of improving practice to the ISU SSTEP.

**Overall Alignment of Habits with the ISU SSTEP:** Teacher C-1’s overall summary rating is a low (L) match to the habits and actions promoted in the ISU SSTEP. The ISU SSTEP was unable to transfer many of the core habits into Teacher C-1’s teaching practices.

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

**Overview**

Teacher C-2, a second year teacher, teaches 10th grade biology and 12th grade chemistry in a suburban community. Due to scheduling constraints, only two observations were conducted. The first observation was in his 10th grade biology class. There were 14
students this day and Teacher C-2 had students form their desks into a semi-circle in order to watch a video and hold a discussion. Students appear curious and eager to watch the video.

**Content, Activities, COP Coding**

Classroom instruction was broken into several components. Students were covering a unit on biological evolution, and Teacher C-2 had students view a video. While showing the video, Teacher C-2 monitored students to see that they gave the video their full attention. Part way through the video, Teacher C-2 hit pause to check students’ understanding with this question:

“What role did the evolution of an Acanthostega play in the evolution of land animals?”

Several students raised their hands, and Teacher C-2 waited several seconds, while giving eye contact to each student. A student is called upon, provided an answer, and a short discussion ensued. The video was resumed, and Teacher C-2 paused several other times to discuss the video.

Group discussions appear to be a common activity in the classroom. Most students were involved in the discussion, and the conversation turned toward the nature of science. Students were familiar with several aspects of the nature of science, and students shared their ideas with the class. Following the discussion Teacher C-2 provided students with a three page article from a popular science journal, as well as a list of questions accompanying the article. Students were given time in class to read and answer the questions.

During a second observation students of Teacher C-2 were given a task to develop a procedure for determining vinegar’s actual pH. The teacher reported that this was the first time he had done this lab, and that he had just recently thought of it. However, students have
obviously done this sort of lab before as evidenced by the fact that the teacher told students this was not the first procedure they have had to develop this year.

During the first lesson Teacher C-2 utilized group interactions to consolidate ideas, and provided content that was significant and worthwhile. Active participation was encouraged, and ideas were freely challenged while also valued. During the vinegar lab Teacher C-2 provided students with a challenging activity. During the lab Teacher C-2 was supportive, though after the lab no consolidation of students’ work was attempted. These teacher actions reflect moderate to high COP ratings (Figure 8).

**Teacher Behaviors and SATIC Pattern**

Teacher C-2’s interaction pattern includes a high percentage of thought-provoking questions and a mixture of teacher-centered and student-centered responses. Teacher C-2 made extensive use of wait time, and positioned himself throughout the room.

**Questioning:** During one observation Teacher C-2 posed nine questions. Of these, one was short-answer (SATIC 3b), five were thought-provoking short answer (SATIC 3c), and three were extended-answer (SATIC 4). Teacher C-2 used an enthusiastic tone of voice and students were responsive. Teacher C-2 picked from a variety of students, avoiding selecting the same individual multiple times.

**Responding:** Responses to student comments was an equal mixture of teacher-centered and student-centered, as defined by the SATIC coding guide. Teacher-centered responses included acknowledging student comments (SATIC 6; 3 incidents), repeating student comment (SATIC 7; 1 incident), and clarifying or interpreting what student said (SATIC 8; 1 incident). Student-centered responses included asking the student to clarify or elaborate (SATIC 11; 4 incidents) and using the student’s question or idea (SATIC 12; 1
incident). In at least one instance Teacher C-2 struggled to find a way to respond to a student
comment. A student had responded with an inaccurate answer, and caught off guard,
Teacher C-2 posed a rhetorical question, “So you’re saying it’s somewhere in between?”
The student replied, “ya,” and Teacher C-2 appeared unsure how to respond, giving the
student a curious look and saying “oh.” This sort of interaction was uncharacteristic of
Teacher C-2, but does highlight the difficulty of making an on the spot analysis of student
comments and articulating thoughtful responses.

Figure 8: COP coding for Teacher C-2

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

Non-verbal Behaviors: Teacher C-2 shows a strong ability to engage students in
meaningful discussions. He is very relaxed in front of students, making use several teacher
behaviors promoted in the ISU SSTEP, such as positive non-verbals, high levels of eye
contact, and portraying to students a natural inquisitiveness. After posing a question that had
many possible answers, Teacher C-2 began counting responses on his fingers, implying that students should work to generate a lengthy list of answers. Teacher C-2 also made extensive use of wait time. After posing a question, Teacher C-2 would pause for 3-5 seconds, even if some students raised their hands. This action is advocated by the ISU SSTEP in order to provide all students time to elaborate in their thinking, and to discourage students from opting out of thinking when they see another student raise their hand. During the vinegar lab Teacher C-2 walked around observing and listening, taking questions, and interacting with students as necessary. Some off-task behavior took place, possibly because Teacher C-2 positioned himself where he could not observe other students.

**Perceived Goals for Students**

In the on-line questionnaire, Teacher C-2 reported seven goals he currently has for students:

a) *Students will be critical thinkers and effective problem solvers. (#2, #4)

b) *Students will be creative (#7)

c) *Students will be respectful and good community learners

d) *Students will demonstrate a clear understanding of the nature of science (#3)

e) *Students will demonstrate a clear understanding of science content (#11)

f) *Students will demonstrate effective communication (#5)

g) *Students will demonstrate a high degree of self-efficacy in the sciences. (#1, #10)

Teacher C-2 had 51 students complete the goals questionnaire (*Figure 9*). The lowest score was Goal #6: Students will participate in working toward solutions to local, national, and/or global problems (mean = 2.82, SD = 1.26). While students felt the Teacher C-2 placed “little” emphasis on this goal, all other goals they felt he placed “moderate” emphasis. The second lowest score was for Goal #12: Students will demonstrate an awareness of the importance of science in many careers (mean = 3.14, SD = 0.70). Low scores on these two goals is similar to other teachers. While the overall scores for Teacher C-2 are lower than the
average scores of other teachers, this does not necessarily reflect a poorer emphasis of goals. Instead, it is likely that these students were more reflective and did not inflate their impression of Teacher C-2. Other data sources do not indicate that Teacher C-2 places less emphasis on student goals than other teachers in the study.

Figure 9: Student goals questionnaire results for Teacher C-2 (N = 51)

Interview

Teacher C-2 identified the science teaching methods and Nature of Science courses as key in preparing him as a science teacher.

I would say the science methods and nature of science did the most [for me]. Those two were the most effective in getting me to understand the crucial role of the teacher in the classroom. It’s so important to know. I had to relearn [the content] all over again in a different sense. I didn’t really know the content until I was forced to teach it in an effective way. I’d say the [courses] that had the least impact were ones in the content area because I didn’t learn them because they were being delivered in an ineffective manner.

I think the way [the science methods instructor] teaches it is [a critical aspect of the course], in that he models everything that you should be doing in the classroom as the instructor. He models everything and weaves it into the methods course.
Teacher C-2 emphasized that the RBF paper was a helpful tool. The RBF did not serve only one purpose, but accomplished several purposes at once.

I thought it was a very effective way to assess. But it was more modeling the assessment of yourself. Because if you’re given a test, someone else assesses it. But if you’re asked certain questions in an oral defense, in that nature, you’re being forced to assess yourself and provide a critique for yourself which is far better for the individual than [an assignment where you are simply] receiving a grade.

The statement above concerning the significance of the RBF is consistent with other observations. Teacher C-2 is reflective of his teaching practices, and points to educational research as the basis of much of his understanding and decision-making. He also explained that the cornerstone of his teaching is his set of goals for students. These goals permeate throughout all other aspects of his teaching.

Knowing how everything a teacher does promotes your student goals for learning in a classroom. Everything from how you walk into a room, to your body language, to how you position yourself. I’m still pretty new in the game so I constantly have to keep working on that, wait time. Tying all that together and figuring out, ok, I know where my students are today.

The reason my student goals are so important is because you’ve got to do the right thing because it’s the right thing to do. You know that that’s your desired target: to be critical thinkers, be effective problem solvers, be comfortable with setbacks, those kinds of things, because you know that is what you want them to end of being as adults. What we stated there is [student goals are] your target, that’s what you want the whole class to [achieve] by the time you’re done with them.

When asked about his role in promoting these goals, Teacher C-2 identifies questioning as the most important tool he uses. In order to help students, he believes that he must gain an understanding of the individual.

[Effective questioning involves] trying to diagnose what they know and what they don’t know, and what they think they know but isn’t so. Then at the same time using positive non-verbals, and wait time to make sure that you elicit information back. And then once you get the information, all the students’ responses, you try to take that piece of knowledge, and sculpt it, and have them sculpt that knowledge to the
desired conceptual state. While you’re doing this you’re trying not to reject ideas that are really off the mark. You’re trying to actually acknowledge them. You’re trying to string them along a path of knowledge through your questioning. It’s the constant choice of, ok do I use an extended-answer question here or a short-answer question here. Because there are times where you use an extended-answer question because you get a lot deeper thoughts. But there are times where a short-answer may be warranted. It just depends on the situation.

Note that Teacher C-2 sees the classroom as an organic environment where he continually adapts to meet the needs of the situation. He points out that there are not single solutions or tricks that apply to all situations. The example he uses is that while we often perceive extended-answer questions as most desirable, there are situations when others are appropriate. This level of reflection is highly consistent with the ISU SSTEP.

**Artifacts**

Teacher C-2 utilizes several types of assignments and assessments in his instruction. Handouts accompanying lab activities provide clear objectives and background information, but are careful to place decisions into the hands of students. Handouts typically include several questions so students think about the significance of procedures, data organization, and controlling variables.

Exams generally contain no fill-in-the-blank, multiple choice, or true-false questions, which place emphasis on simple recall of terminology. Tests instead emphasize students applying their understanding to solve problems in different contexts. For example, one exam required students in groups of four to design a space craft and write a story about leaving a futuristic polluted and unsustainable Earth. Students had to divide up work, research various elements, attach journal articles, and meet deadlines. Such an exam promotes several student goals, such as
a) Students will be critical thinkers and effective problem solvers.
b) Students will be creative
e) Students will demonstrate a clear understanding of science content
f) Students will demonstrate effective communication
g) Students will demonstrate a high degree of self-efficacy in the sciences.

Other assignments emphasize understanding how to analyze information for their value in accomplishing a task. For example, students located articles or advertisements making scientific claims, and analyzed what aspect of science was addressed. Such assignments promote creativity, critical thinking, and developing a deeper understanding of the nature of science.

Summary

Habits of Understanding: Teacher C-2’s habits of understanding have a moderately high (MH) match to the ISU SSTEP. He describes and integrates several key characteristics of effective teaching, including the value of a research basis, learning theories, goal development, teacher behaviors, and self-assessment.

Habits of Action: Teacher C-2 invests a significant amount of time developing activities that provide students with meaningful experiences. He uses positive non-verbals, proximity, and questioning as tools to promote his student goals. Each of these areas exhibit a level of mastery well beyond the level attained by most second year teachers, and so his habits of action were rated as a high (H) match to the ISU SSTEP.

Habits of Reflection: Teacher C-2’s habits of reflection are a high (H) match to the ISU SSTEP. Teacher C-2 makes frequent reference to the teacher’s role in promoting student learning, such as relating the impact of his questioning on student participation during classroom discussions. He also recognizes the need to put in far more than the
minimum amount of time in order to create a dynamic learning community. These areas of reflection are addressed in the ISU SSTEP.

**Habits of Improving Practice:** Teacher C-2’s habits of improving practice align moderately (M) with the ISU SSTEP. While he identifies the importance of strategies such as effective questioning, wait time, and positive non-verbals, he did not address any ways by which he can self-assess his current strengths and weaknesses, such as audio or video recording and SATIC coding. The ISU SSTEP did not adequately transfer the elements of this habit to Teacher C-2.

**Overall Alignment of Habits with the ISU SSTEP:** The ratings above lead to a moderately high (MH) match between Teacher C-2’s habits and those promoted by the ISU SSTEP. Teacher C-2 has a rich repertoire of understandings about effective instruction, and he utilizes a number of research-based strategies to promote his goals for students. Classroom activities are usually inquiry based, and students are engaged in meaningful learning leading to depth in the areas of both science content and the nature of science. The one area where a disconnect exists is in his habits of improving practice, a habit that is a key component of the ISU SSTEP.

**Teacher C-3: 1st Year Teacher (Current Program)**

**Overview**

Teacher C-3 is in her first year of teaching at a high school located in a middle class, suburban community. She expresses frustration with some aspects of her teaching schedule. She has been assigned a health class which is not within her endorsement area. She also teaches several sections of biology, with which she feels much more comfortable. Teacher
C-3, like many first year teachers, struggles with organization and classroom management. However she puts in long hours, is well liked by her students, and is optimistic.

**Content, Activities, COP Coding**

While efforts were made to do otherwise, much of Teacher C-3’s instruction was teacher-centered. The first observation took place in Teacher C-3’s health class. During this observation Teacher C-3 labeled drawings on an overhead projector while students copied the notes. Much of the content was heavily focused on vocabulary with few links to health related topics. This aspect of her teaching does not align with the ISU SSTEP, which advocates emphasizing central science concepts, or big ideas, over terminology. Teacher C-3 made efforts to engage students. Throughout the lesson she posed questions to students, providing neutral valued acceptance of both correct and inaccurate ideas. Because of the strong rapport with Teacher C-3, students took intellectual risks.

During a second observation Teacher C-3 selected a video for students to watch. Prior to the video, Teacher C-3 set clear behavior expectations. She then started the video and returned to her desk to grade papers. The video was never paused to discuss key points, and many opportunities were missed to clarify concepts. The significance of watching the video was not established, as no time was used to consolidate ideas after the video. The ISU SSTEP models strategies in selecting educational resources that can be used to draw students’ attention to key concepts. The ISU SSTEP did not adequately transfer these strategies into Teacher C-3’s understanding.

The third observation followed the same style as the first. A Power Point slideshow was used to teach evolutionary concepts. Students were given an exact copy of the slides
prior to the lesson. Teacher C-3 posed questions throughout the slideshow, however it was unclear that students were actively engaged in their thinking.

Based upon these observations the capsule ratings were low to moderate (Figure 10).

![Figure 10: COP coding for Teacher C-3](chart)

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

**Teacher Behaviors and SATIC Pattern**

**Questioning:** Teacher C-3 posed a large number of low level initiatory questions during lessons, as defined by the SATIC coding guide, a tool promoted in the ISU SSTEP. The sum over three observations includes 38 dichotomous (SATIC 3a) and short-answer questions (SATIC 3b), 6 thought-provoking questions (SATIC 3c), and zero extended-answer questions. The number of dichotomous and short-answer questions constitutes 86% of the total number of questions. While these types of questions may be appropriate in a
limited number of situations, the ISU SSTEPS advocates the habit of asking open-ended questions such as thought-provoking and extended-answer questions. The ISU SSTEP maintains that these sorts of questions, when used in conjunction with positive non-verbals and wait time, are more likely to elicit longer and more elaborate responses. Open-ended questions also help shift the emphasis from rote memorization of terminology to understanding central science concepts.

**Responding:** Teacher C-3’s responses were typically always teacher-centered, as defined by the SATIC coding guide. This included acknowledging student comments (SATIC 6; 2 incidents), confirming student comments (SATIC 7, 4 incidents), repeating student comments (SATIC 8; 39 incidents), clarifying or interpreting student comments (SATIC 9; 2 incidents), and answering student questions (SATIC 10; 4 incidents). Each of these types of responses has the tendency to reduce the length and depth of student responses, and is not promoted by the ISU SSTEP. Additionally, the excessive number of incidents of repeating a student comment is also coded as an annoying mannerism (SATIC 15). Student-centered responses were infrequent. Between the three observations only two instances were observed.

**Non-verbal Behaviors:** Teacher C-3 did not often use wait time I or II. Wait time I refers to the period of time immediately following an initiatory question posed by the teacher, and in general should last at least 3-5 seconds. The ISU SSTEP emphasizes that this brief pause is critical to provide all students time to contemplate the question, and wait time also helps establish a classroom expectation that all students participate rather than defer to those who quickly raise their hands. Wait time II refers to the period of time following a student’s response to a question. The period of silence is generally five or more seconds, and
promotes the benefits associated with wait time I. The use of wait time I and II is emphasized in the ISU SSTEP. The infrequent use of wait time I and II by Teacher C-3 likely is associated with the posing of short answer questions, as it is difficult to encourage thoughtful contemplation in students from such questions.

Teacher C-3 used positive non-verbals, such as maintaining eye contact with students and having an upbeat and interested facial expression. These sorts of behaviors are promoted in the ISU SSTEP.

**Perceived Goals for Students**

Teacher C-3 did not submit an on-line survey. However, she did provide a list of student goals, but did not mark which are currently most emphasized. Teacher C-3’s ten goals for students are:

a) Students will demonstrate ownership of their learning.
b) Students will exhibit critical thinking and problem solving skills. (#2, #4)
c) Students will display effective communication skills. (#5)
d) Students will demonstrate a clear and robust understanding of the fundamental concepts of science. (#11)
e) Students will demonstrate an awareness of science in the real world and its applications.
f) Students will demonstrate the ability to work effectively, individually and collaboratively.
g) Students will exhibit responsibility and respect.
h) Students will exhibit comfort with uncertainty.
i) Students will exhibit creative thinking. (#7)
j) Students will demonstrate the ability to carry out authentic scientific investigations. (#10)

Teacher C-3 had 22 students complete the goals questionnaire. As seen in Figure 11, all goals have an average rating above 4 (“much”). Four goals shared the lowest mean rating of 4.50. These goals included Goal #4: Students will identify and solve problems effectively
(SD = 0.67), Goal #6: Students will actively participate in working toward solutions to local, national, and/or global problems (SD = 0.74), Goal #11: Students will demonstrate a deep understanding of science concepts rather than covering may insignificant/isolated facts (SD = 0.67), and Goal #12: Students will demonstrate an awareness of the importance of science in many careers (SD = 0.74).

The average goal ratings by students for Teacher C-3 are higher than any other teacher. Evidence from observations and interviews do not align with these high ratings. One way to account for these results is to acknowledge that Teacher C-3 has a very strong rapport with students, and that because the classroom culture often favors low cognitive demands, students may not have reflected sufficiently on the questions to give an accurate assessment.
Interview

Teacher C-3 was very satisfied with the science content and pedagogy courses of the ISU SSTEP. She mentioned the Nature of Science course, two introductory biology courses, the science teaching methods course, and student teaching as most valuable. Teacher C-3 also participated in a student led biology academic learning community. Teacher C-3 described the importance of the Nature of Science course.

Nature of Science was really significant and beneficial because I think it taught me to look at science in a different way. I was used to learning what the science is and the content behind it, and when [the instructor] went through the Nature of Science material it made me think more about [how as] a teacher there needs to be a different mentality for looking at it, and the different approach to teaching it to other people.

Teacher C-3 does not describe the helpfulness of this course in any greater detail, and in fact struggled to identify how her coursework helped build a research-based framework for her teaching. When asked what aspects of the science methods course was helpful or beneficial, Teacher C-3 replied

I really liked being in that small setting with a bunch of other people who wanted to be science teachers, and I think we all collaborated really well. We had a really good group of people who I enjoyed. I learned a lot from everybody else, and watching [the instructor], and how he taught, helped me think about how I wanted to teach, and motivated me to think about those non-verbals and how you’re going to present yourself in front of a group of people.

Teacher C-3 places emphasis on goals in her classroom. At the beginning of the school year she sends a letter to parents with a detailed set of goals for student. These written goals differ from the student goals listed above, as they more precisely define content goals specific to the science course. For example, “Students will label the structures and list the function of different types of cell parts.” Teacher C-3 explained the role her student goals have in her classroom:
I think [students goals] give you focus. It's something that you can look at at the beginning of the year and know where you want to go. And something you can look at at the end of the year and say to yourself “Did I do that?” And you can have your students do the same thing.

Teacher C-3’s rationale for having goals does not closely match the reasoning given by ISU SSTEP. Rather than using goals only at the beginning and end of the school year, the ISU SSTEP presents student goals as a tool to guide teacher decision-making on a daily basis. For example, a teacher reflects upon his or her student goals when modifying a cookbook lab. A teacher might remove a data table and have students determine their own way to organize data. This would promote Goal #2: Students will use critical thinking skills.

Teacher C-3 found her research-based framework very helpful in preparing her for an interview for her current teaching position, and in fact she feels that what she learned through her RBF was responsible for her being offered the position.

I guess the biggest thing with my RBF that helped me was in the interview process…I just felt so confident after coming off the RBF, and writing all that. I felt good, and I knew what I was talking about.

However, her RBF now plays a more nominal role.

I really haven’t looked at my RBF since I started teaching. But the basic knowledge that I have that I wrote about, and all the research that we put into writing that RBF is still in my mind, with the non-verbals.

Teacher C-3 does not seem to see the RBF as a tool to explicitly target her teaching decisions, for example, when selecting and modifying materials and activities. She views the RBF, instead, as a way to stimulate students.

**Artifacts**

Many of Teacher C-3’s materials mirror previous observations. Two exams were analyzed. The first exam consisted of 39 test items. 28 items were multiple choice
questions, 6 items were short-answer recall questions, 1 was fill in the blank, and 4 were thought-provoking short answer. The majority of the test items, the multiple choice questions, are described by the ISU SSTEP as having a limited ability to assess students’ understanding of science concepts.

Teacher C-3 commonly uses labs in class. These labs are typically directive, with a section of “background information,” detailed procedures, a summary of what they should see, and a lengthy list of summary questions. Many of the questions are thought-provoking, however it is argued that many students may struggle because the experiment portion of the lab required little active thinking.

Some assignments promoted creativity and deeper thinking in ways advocated by the ISU SSTEP. During the first observation students in the health class were assigned to write a story in the first-person about the life of a sperm and egg, using all vocabulary terms from flash cards. During the cell unit in biology students developed an analogy between a doughnut factory and the internal structure and processes of a cell. Students chose to either create a poster or write a story.

Summary

Habits of Understanding: Teacher C-3’s habits of understanding are a low (L) match to the ISU SSTEP. When discussing the importance of student goals, questioning, and a research-based framework, she often stated they were useful in order to get students “interested,” or “motivated.” Student interest and motivation are important, however she does not frame her student goals, questioning, and RBF as important in promoting other student outcomes such as deeper comprehension, critical thinking, and effective
communication. The ISU SSTEP’s habits of understanding do not appear to have transferred into Teacher C-3’s practice.

**Habits of Action:** Teacher C-3 exhibits a moderately low (ML) match to the ISU SSTEP in her habits of action. Students are kept attentive during discussions through frequent use of questioning, however deep thinking is never achieved due in part to questioning that is described by the ISU SSTEP as teacher-centered.

**Habits of Reflection:** Teacher C-3 appears to believe that her current state of teaching approximates her desired state of teaching. She identified no specific areas of her teaching in need of improvement, and does not articulate any general strategies that could be used to self-assess and improve practice. The ISU SSTEP modeled several tools that can be used to self-assess teaching practices, which are not used by Teacher C-3. This is not to say the Teacher C-3 is not reflective, however her reflections focus primarily on how to increase students’ participation and interest in class. These actions reflect a low (L) match between Teacher C-3’s habits of reflection and the ISU SSTEP.

**Habits of Improving Practice:** Teacher C-3’s habits of improving practice constitute a low (L) match to the ISU SSTEP. She identifies no specific actions to improve her teaching, such as improving her interaction patterns with students through taping and listening to her teaching. She has no systematic method of identifying other weaknesses, such as her wait time, and takes no proactive measures to address these sorts of practices, such as strategically placing signs around the room as a reminder to wait after posing questions.

**Overall Alignment of Habits with the ISU SSTEP:** Teacher C-3’s overall summary rating is a moderately low (ML) match to the habits and actions promoted in the ISU SSTEP.
Her understanding of effective instruction is missing several important pieces that were promoted in the ISU SSTEP, such as questioning techniques that promote deeper thinking. Classroom activities often place little emphasis on critical thinking, and at times seem to be used to fill time or to meet general science content requirements. Teacher C-3 lacks a coherent plan to self-assess, and appears to measure the quality of her instruction on whether her students appear motivated. The reason that the overall rating is moderately low instead of low is because Teacher C-3 does employ some strategies to improve the quality of learning, such as modifying activities with questions, and developing creative assignments to enhance student learning.

**Summary of Matching between Habits of Graduates and the ISU SSTEP**

A summary of the cumulative ratings for all of the teachers are listed in *Table 5*. The following sections address findings with respect to the two research questions.

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Findings for Research Question 1: Educational Goals for Students

In *The End of Education* Postman (1995) notes that much of educational reform is focused on the *means* of education, but that the *reasons* for learning and schooling are far more important. The reasons for schooling are often reflected in goal statements (Clough, 2003b). The first research question focuses on educational goals for secondary science students. This question was broken in sub-questions:

- a. What student goals do teachers self-report?
- b. What goals do students perceive are emphasized?
- c. What is the supporting evidence from observations and artifact analysis that these goals are promoted?
- d. How do teachers’ student goals compared to those promoted by the ISU SSTEP?

The following discussion addresses each of these sub-questions, supported through observations, interviews, artifacts, and questionnaires. Comparisons involve the program graduates as groups (former and current), as well as graduates and the ISU SSTEP. The following findings are related to educational goals for students:

- **Finding 1**: ISU SSTEP graduates reported having and promoting multiple goals for students.
- **Finding 2**: Students of ISU SSTEP graduates perceived multiple goals being emphasized in their science classrooms.
- **Finding 3**: Graduates of both the former and current ISU SSTEPs exhibited promotion of a similar number of goals, however former ISU SSTEP graduates generally emphasized goals to a greater extent than graduates of the current ISU SSTEP.

The next section addresses *Findings 1-4* with supporting evidence, using comparisons between program graduate groups and between individual graduates and the ISU SSTEP.

**Finding 1**: ISU SSTEP graduates reported having and promoting multiple goals for students.

A common point raised by all teachers during interviews was that in order to be an effective teacher one must identify intended outcomes. These outcomes are expressed
through goals for students. *Table 6* summarizes the number of student goals identified by each teacher, organized to compare programs. The average number of goals was 9.7 for both the former and current ISU SSTEPS.

<table>
<thead>
<tr>
<th>Teacher</th>
<th># of Goals</th>
<th>Teacher</th>
<th># of Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-1</td>
<td>7</td>
<td>C-1</td>
<td>12</td>
</tr>
<tr>
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<td>7</td>
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<tr>
<td>F-3</td>
<td>12</td>
<td>C-3</td>
<td>10</td>
</tr>
<tr>
<td>Average of Former Program Graduates</td>
<td>9.7</td>
<td>Average of Current Program Graduates</td>
<td>9.7</td>
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</table>

*Finding 2: Students of ISU SSTEP graduates perceived multiple goals for students.*

Students of both former and current ISU SSTEP graduates indicate that multiple goals are promoted in their classrooms (*Figure 12*). See *Appendix C* for a complete list of goals. The total number of students completing the goals questionnaire was 128 for the former ISU SSTEP graduates and 73 for the current ISU SSTEP graduates. As stated in the teacher analyses, only two out of the three graduates from each program chose to administer this questionnaire.

For all goals, students of graduates completing the former ISU SSTEP reported a higher emphasis than students of graduates of the current ISU SSTEP. The difference in perceived emphasis of goals varied from 0.2 to 0.7. The largest average rating difference, 0.7, occurred for Goal #3: Students will convey an understanding of what science is, what real scientists are like, and how science really works. Two goals had an average rating
difference of 0.2, Goal #1: Students will convey self-confidence and/or a positive self-image, and Goal #8: Students will set goals and/or self-evaluate.

For both groups, the average ranking for every goal is at a moderate (3) or higher level of emphasis. In the classrooms of graduates of the former ISU SSTEP, 11 goals were perceived to have been promoted at a level between “much” (4) and “very much” (5). Only one goal was perceived to have between “moderate” (3) and “much” (4) emphasis, Goal #6: Students will participate in working towards solutions to local, national, and/or global problems. In classrooms of graduates of the current ISU SSTEP, two goals were perceived to have been promoted at a level between “much” (4) and “very much” (5). These include Goal #2: Students will use critical thinking skills, and Goal #9: Students will convey a positive attitude about science. The other 9 goals were perceived to have been promoted at a level between “moderate” (3) and “much” (4) emphasis.

![Figure 12: Average rating of student goals questionnaire](image-url)
The difference in average ratings between graduates of the former and current ISU SSTEP may not be due to stronger emphasis, but rather to differences in perceptions of the teachers. Bergman (2007) identifies several possible sources of discrepancies in student attitudes toward teachers:

- Graduates of the current ISU SSTEP may have higher expectations, and thus may receive slightly lower ratings due to student resentment.
- Students in the classrooms of a former ISU SSTEP graduate may have a more favorable attitude toward their teacher if they face fewer challenges.
- Students may give higher ratings to teachers who are not as demanding.

The results of this questionnaire are also limited because only two teachers from each program chose to administer it.

**Finding 3: Graduates of both the former and current ISU SSTEPs exhibited promotion of a similar number of goals, however former ISU SSTEP graduates generally emphasized goals to a greater extent than graduates of the current ISU SSTEP.**

*Figure 13* compares the extent to which graduates of the former and current ISU SSTEP were observed promoting individual goals in their classroom. Five of the twelve goals, Goals 1, 2, 5, 10, and 11 show a sizable difference (0.5 points or greater) in promotion between graduates of the former and current ISU SSTEP. Two goals, Goals 6 and 12, were observed being promoted in classrooms of graduates of the former ISU SSTEP, but not in classrooms of graduates of the current ISU SSTEP. The remaining five goals, Goals 3, 4, 7, 8, and 9, were promoted to a similar extent in all classrooms. Compared to the student questionnaire results (*Figure 12*), which showed that students of teachers who went through the former ISU SSTEP perceive a slightly higher emphasis of goals, results of the average observed emphasis of goals (*Figure 13*) show no clear trends. One reason may be due to the difference in the range of values of each instrument. The student questionnaire has five
possible choices, while the instrument used for observing emphasis of goals has three possible choices. If the student questionnaire had been limited to three choices, the results may have showed more erratic results, as students would have had to fit their perception of goal emphasis into less precise categories (e.g., low, moderate, or extensive).

In any case, results from both the student questionnaire and observation instruments support the finding that graduates of the former ISU SSTEP generally emphasized student goals to a greater extent than graduates of the current ISU SSTEP.

**Findings for Research Question 2: Habits of ISU SSTEP Graduates**

The second research question addressed habits of understanding, action, reflection, and improving practice exhibited by former and current ISU SSTEP graduates. This question sought to distinguish whether one program had a greater impact in preparing graduates to exhibit the habits promoted and modeled in the ISU SSTEP. Findings are as follows:
Finding 1: The habits of understanding, action, reflection, and improving practice exhibited by ISU SSTEP graduates align at varying degrees to those promoted and modeled in the ISU SSTEP.

Finding 2: The extent to which a graduate has developed his/her understanding of these habits does not appear to be strictly based upon which program he/she graduated from.

Finding 1: The habits of understanding, action, reflection, and improving practice exhibited by ISU SSTEP graduates align at varying degrees to those promoted and modeled in the ISU SSTEP.

Evidence for this finding comes from observations, interviews, artifacts, and the online questionnaire. A summary of the alignment between graduates’ habits and those promoted by the ISU SSTEP is displayed in Table 7.

<table>
<thead>
<tr>
<th>Habits of Understanding</th>
<th>F-1</th>
<th>F-2</th>
<th>F-3</th>
<th>C-1</th>
<th>C-2</th>
<th>C-3</th>
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</thead>
<tbody>
<tr>
<td>Habits of Understanding</td>
<td>M</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>MH</td>
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<tr>
<td>Habits of Actions</td>
<td>M</td>
<td>H</td>
<td>L</td>
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<tr>
<td>Habits of Reflection</td>
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<tr>
<td>Habits of Improving Practice</td>
<td>M</td>
<td>H</td>
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<td>L</td>
<td>MH</td>
<td>L</td>
</tr>
</tbody>
</table>

| Overall Summary         | M   | H   | L   | L   | MH  | ML  |

$H = $ High match; $MH = $ Moderately High match; $M = $ Moderate match; $ML = $ Moderately Low match; $L = $ Low match

Matches between teachers’ habits and those promoted by the ISU SSTEP ranged from low (L) to high (H). Matches for individual teachers were typically consistent across all four habits and the overall summary. For example, Teacher F-2 matched high (H) in all categories, and Teacher C-2 matched either high (H) or moderately high (MH) in all categories. Those teachers who matched low (L) in at least one category did not match high (H) in any categories.
Finding 2: The extent to which a graduate has developed his/her understanding of these habits does not appear to be strictly based upon which program he/she graduated from.

Table 7 above lists the ratings within each category of habits and an overall summary rating for all graduates. When comparing the ratings of graduates of the former ISU SSTEP to the current ISU SSTEP, no clear distinctions are apparent. Both groups contain a similar number of low (L) through high (H) ratings. The results of this study could lead one to the conclusion that the current ISU SSTEP is no more effective than the former ISU SSTEP at preparing preservice teachers to model the habits espoused in the ISU SSTEP. However, one would also quickly note that the sample size is very small. Quantitative analysis of these data provides ambiguous information. A qualitative case study analysis is more appropriate. In such instances, “a vivid, specific narrative of each participant and the program prompts readers to make comparisons to their particular circumstances (Bergman, 2007).” The following summaries provide a closer window into the unique situations of the participants of the study.

Teacher F-1: Many of the students in the ISU SSTEP are individuals who recently finished undergraduate studies or have worked professionally for only a couple of years. This is not the case with Teacher F-1. He earned undergraduate degrees in biology and psychology, and through a number of opportunities has worked in many professions. These include working in computer sales for around ten years, medical sales for seven years, and architectural work for three years. Teacher F-1 has wide expertise, is driven, has vast creativity, is a natural leader, and excels at what he sets out to do. His science methods instructor stated that Teacher F-1 came into the program with many developed teacher qualities already matching qualities of effective teaching and desired end of the ISU SSTEP. This is not to say that he
learned nothing from the program. In fact, Teacher F-1 pointed to several components of the program that were important, such as student goal development and questioning skills. However, from the interviews it was apparent that Teacher F-1 does not reflect on other components promoted in the ISU SSTEP, including the self-assessment tools studied in the ISU SSTEP, such as audio recording and SATIC coding. Teacher F-1 is an individual who is goal-driven, and when he is satisfied, he moves on to a new challenge. This appears to be the case in teaching. At the time of the interview Teacher F-1 expressed that he had accomplished all the goals he had set for his teaching, and he has recently left the teaching profession to explore new endeavors.

*Teacher F-2*: Student teaching can be a positive or negative experience for student teachers. Teacher F-2 is one whose student teaching experience is perhaps best described as utopian. Teacher F-2 was placed with a supervising teacher who graduated from a science teaching education program with a teacher preparation philosophy and structure similar to the ISU SSTEP. This program included three sequential methods courses, and two required nature of science courses. This teacher then went on to take a third nature of science course under his own accord. The research-based program he studied under prepared this supervising teacher well, and Teacher F-2 benefited immensely. In fact, Teacher F-2 stated that student teaching was the most valuable part of his teaching preparation, because it put into practice the things that he had learned in the ISU SSTEP, and it took place in an environment where he received continual, meaningful feedback. Teacher F-2 got a student teaching experience that matches the ISU SSTEP model, so he essentially received an additional methods course that ran 40 hours per week for 15 weeks.
The ISU science methods instructor also points out that he and Teacher F-2 have had many conversations over the phone regarding science teaching. The science methods instructors states that conversations with former students is common, however the number of conversations he has had with Teacher F-2 was unusually greater than with most other former students. The impact of Teacher F-2’s experiences has had far reach effects, as he now takes on student teachers from the ISU SSTEP.

**Teacher F-3:** While Teacher F-3 spoke well of his experiences while in the ISU SSTEP, he also pointed to several disappointments while seeking licensure. When Teacher F-3 inquired about obtaining licensure from ISU to teach science, he was told by an education advisor (not science education faculty) that even though he had a four-year biology degree from a state college, he still had to take an extensive list of science courses from ISU. It was not until just prior to his student teaching that he learned that he had been misadvised and had taken courses that were not needed. In addition to taking science content courses that were not needed to obtain licensure, Teacher F-3 also felt that these same courses were ineffective in preparing him as a teacher:

> In my ISU chemistry classes, I did not learn a single thing that I am turning around and teaching my students. However, if I would have had a chemistry prof actually “teach” me the material that I would have to teach my students, I feel that would have prepared me more.

These judgments that the science content courses did little to prepare him to teach extend to most other general education courses. Teacher F-3 felt that there were too many “theory of” and “foundations of” courses, and too few that show teachers how to teach.
These insights from Teacher F-3 highlight that the ISU SSTEP interacts with other departments and offices within the university. Teacher F-3’s experiences will lead to a recommendation that careful attention be given to how students are advised.

**Teacher C-1:** The science methods instructor states that Teacher C-1 came into the ISU SSTEP with strong notions of what teaching is, and never opened his mind to the program. For example, Teacher C-1 stated in the interview that he felt that the development of student goals was unconstructive because “the system is really going to work against you on almost all of them. It’s kind of setting you up for disappointment.” Teacher C-1 also never opened up to consider the potential value of using a research-based framework. When asked in what ways his RBF was helpful to his teaching, he stated that it no longer informs his thinking and decision-making. Teacher C-1 encountered a great deal of resistance while teaching, and in his interview expressed deep dissatisfaction with public schooling because of these constraints. Teacher C-1 did not find ways to navigate through these constraints, and at the time of the final interview had ended his teaching career to pursue other interests.

It’s possible that some people will never open their minds to consider the value of the habits promoted and modeled in the ISU SSTEP, and therefore the ISU SSTEP is not a good match for certain individuals. If this is the case, it would be advantageous to both the preservice teacher and the science education faculty to determine this prior to entry into the program. This would save the preservice teacher valuable money and time, and would enable others to apply for entry into the program.

**Teacher C-2:** One characteristic that describes Teacher C-2 is *personal discipline*. His lesson preparations, activities, questioning, assessments, and interviews all point to this characteristic. During phone conversations leading up to the final interview, conversations
about Teacher C-2’s personal life point to this quality permeating throughout all he does. So it is no surprise that Teacher C-2 is highly reflective of his teaching, which brings his teaching into close alignment with the ISU SSTEP. In fact, this quality sets him up to profit greatly from the ISU SSTEP.

**Teacher C-3:** Many teachers benefited in tangible ways as a result of the ISU SSTEP, including Teacher C-3. She points to the interview that led to her being hired as a teacher as evidence. She stated that the RBF and oral defense likely bumped her over the other candidates applying for the science teaching position, because she was able to clearly articulate her responses to questions during the interview. Many of the ideas promoted by the ISU SSTEP no longer inform her thinking. Teacher C-3 explained that she doesn’t refer back to her RBF anymore, which is consistent with observations and her responses during the interview. It appears that Teacher C-3 has created a classroom environment and teaching style that suits her, and so no longer senses a need to reflect back on the habits advocated and modeled in the ISU SSTEP.

As explained in the case analysis section, during the interview Teacher C-3 emphasized creating a classroom environment where students participate and are interested and motivated. However, these seemed to be the only qualities she pursues. Even with many attempts to probe her thinking, Teacher C-3 did not mention her list of student goals as a part of the equation. She appears to no longer reflect on her goals, except when listing them on a handout at the beginning of the course.

This is an individual who warrants further study. Why did the program not affect her? What can be done to reach those like her? What variables could have been changed to
try to help her retain the habits modeled in the ISU SSTEP? Such questions will be addressed in *Chapter 5*. 
CHAPTER 5: DISCUSSION AND CONCLUSIONS

This study compares the extent to which the educational goals and habits promoted by the former and current Iowa State University Secondary Science Teacher Education Program (ISU SSTEP) transfer out into its graduates’ teaching practices. The goal is to compare the effects of the former and current programs on preservice teachers in order to understand the strengths and deficiencies of the current ISU SSTEP so that additional improvements can be implemented. This study examined three teachers from the former ISU SSTEP and three teachers who graduated from the current ISU STEP to determine to what extent their teaching habits align with the habits promoted and modeled in the ISU SSTEP.

Results of this study show that graduates of both ISU SSTEPs achieved varying levels of alignment with the habits taught in the ISU SSTEPs (*Table 8*). These results do not match the results obtained by Bergman (2007). *Table 9* summarizes the matching of habits of teachers participating in Bergman’s research study.

A total of six graduates participated in this study. Results are derived from classroom observations, questionnaires, artifacts, and interviews. These data combined afford the opportunity to derive implications that inform the future direction of the ISU SSTEP.

**Implications**

*Confounding factors*

Results from this study regarding the extent to which the educational goals and habits promoted by the ISU SSTEP transfer out into its graduates’ practices showed no clear differences between the former ISU SSTEP group and current ISU SSTEP group. Individual teachers from both groups ranged from a low to high match to the habits promoted by the
Table 8: Alignment of habits between graduates and the ISU SSTEP (Taylor study)

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<th>F-3</th>
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<tr>
<td>Habits of Understanding</td>
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Overall Summary: M H L L MH ML

H = High match; MH = Moderately High match; M = Moderate match; ML = Moderately Low match; L = Low match

Table 9: Summary of habits matching between graduates and ISU SSTEP (Bergman study)

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<td>Habits of Understanding</td>
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<tr>
<td>Habits of Action Plan/Improvement</td>
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Overall Summary: ML ML ML MH L MH MH MH H H

H = High match; MH = Moderately High match; M = Moderate match; ML = Moderately Low match; L = Low match

ISU SSTEP. In contrast, Bergman’s (2007) study reported that the educational goals and habits promoted by ISU SSTEP transferred much more extensively to graduates of the current program compared to graduates of the former program.

Several explanations may account for the lack of difference between ISU SSTEP graduates of the former and current programs reported here. First, this study included only three subjects from the former program and three from the current program. The results reported here might simply be due to the small sample size that does not accurately represent the entire population of graduates from the former and current program. This study is part of a larger study of the ISU SSTEP, and results reported here and by Bergman (2007) will
contribute data to the larger study that will together provide a more representative sample of
graduates from both the former and current ISU SSTEPs.

Second, a host of other variables other than the ISU SSTEP may influence the extent
that the educational goals and habits promoted by the current and former ISU SSTEPs
transfer out into its graduates’ practice. The following are some of those factors:

1. *Attitudes about teaching.* All preservice teachers enter the program with existing prior
   knowledge about and values toward education and teaching. Some preservice teachers
   come into the program with strong views about teaching that do not align with the ISU
   SSTEP. While some preservice teachers are open-minded to considering what the ISU
   SSTEP promotes, other hold tightly to their pre-existing views. In such cases, the ISU
   SSTEP may be unable to influence some preservice teachers to emulate the habits
   promoted by the ISU SSTEP.

2. *Placement with cooperating teachers.* Several variables are considered when placing a
   student teacher with a cooperating teacher, such as the available pool of cooperating
   teachers, the number of student teachers needing placement, science content matches,
   personal recommendations, proximity of the school, school demographics, the time of
   year of placement, and convenience. Student teaching placements are often not under the
   control of ISU SSTEP science education faculty. Even if it were, the number of
   cooperating teachers exhibiting habits consistent with the ISU SSTEP falls well short of
   the number of student teachers that must be placed. Nearly all participants identified
   student teaching as a pivotal and crucial component of their teacher preparation, whether
   the experience was in the positive or the negative. Previous research has indicated that
   the student teaching semester is crucial, and that poor experiences may wash out the
effects of university teacher education programs. Some graduates stated their cooperating
teacher promoted habits matching the ISU SSTEP, others encountered cooperating
teacher that demanded practice inconsistent with habits promoted by the ISU SSTEP. The wide variance among student teaching experiences expressed by subjects in this study likely affects the extent that goals and habits promoted by ISU SSTEP transfer out into its graduates’ practices.

3. Student teacher supervisors. Supervisors hired by the university observe student teachers and meet with them individually to offer feedback and counseling. Supervisors are sometimes ISU education faculty and graduate students, but usually former teachers and administrators. Thus, individuals unfamiliar with the habits promoted by the ISU SSTEP usually conduct supervision. This results in supervision that may or may not be consistent with the ISU SSTEP. For example, the science methods instructor shared a story of a graduate from the current ISU SSTEP who, after being observed by his supervisor, was advised to stop using wait time because of the perceived awkward pauses. Both the student teacher and the cooperating teacher, who understands the value off using wait time, were astounded. The student contacted the science methods professor who then contacted the head of student placement services. Because of this support for the student teacher from both his cooperating teacher and his science methods professor, the situation was resolved in a very positive manner. The student teaching semester greatly influences preservice teachers, and both the cooperating teacher and university supervisor play a key role in preservice teacher development.

4. ISU SSTEP support during student teaching. Graduate students in the current ISU SSTEP student teach the same semester that they are taking their third science methods course.
Thus, during their student teaching semester they are consistently reminded of the goals and habits promoted by the ISU SSTEP. Moreover, they have ready access to ISU SSTEP faculty when questions or concerns arise. However, undergraduate students in the current ISU SSTEP student teach after completing their third methods course. Undergraduates in the former ISU SSTEP student taught after completing their single science methods course. The gap between completing the final methods course and their student teaching semester is, at the very least, a full summer. However, students may choose to wait longer, and for many the student teaching semester may occur eight months after completing their final science methods course. The time between taking the methods course and student teaching undoubtedly is an important factor that must be considered when rating the graduate’s match to the ISU SSTEP, because the longer the gap in time, the more likely it is that the habits they developed during the program will blur.

5. **ISU SSTEP support following graduation.** For most undergraduate ISU SSTEP students, their student teaching is the last requirement completed prior to receiving licensure. Currently, no formal or systematic support is readily available to these teachers. Once they graduate and obtain a teaching position, most are left to fend for themselves. Some choose to keep in close contact with the science education faculty, ISU SSTEP classmates, or teach in a school with colleagues who value the habits advocated by the ISU SSTEP. Others choose to face their first years without contacting those associated with ISU SSTEP. This creates a wide difference in the level of support a graduate may receive during their first critical years of teaching.
6. Institutional constraints. Graduates of the ISU SSTEP, or any program for that matter, enter a profession that has explicit and implicit expectations for practice. Many of these expectations differ markedly from the goals and habits promoted by the ISU SSTEP. Subjects in this study and in Bergman’s (2007) study spoke extensively about institutional norms that were inconsistent with the goals and habits promoted and modeled by ISU SSTEP. Graduates of ISU SSTEP differed markedly in their willingness and ability to overcome institutional barriers to goals and habits promoted by ISU SSTEP.

Recommendations for ISU SSTEP

Results and analyses of the situations unique to each participant inform assessment of the ISU SSTEP. The following are recommendations for the ISU SSTEP:

1. Have undergraduate students take their third and final science methods course during the same term they student teach. Currently, undergraduates in the ISU SSTEP are prone to less supportive preparation for two reasons. First, students enter student teaching after completing the methods courses, and sizable lapse in time may pass before they student teach. With this passing time the habits promoted by the ISU SSTEP will tend to become blurred. Second, undergraduate students are no longer in constant contact with either science education faculty or members of their ISU SSTEP cohort. Effort should be made to determine the importance of the third science methods course occurring during the student teaching semester, and perhaps alter ISU SSTEP so that undergraduates complete that course in conjunction with student teaching. If that is not possible, a less desirable solution is to require undergraduate students to complete their student teaching the semester immediately following the completion of their third science methods course.
2. *Provide undergraduate students with support immediately following student teaching.*

M.A.T. students have an additional methods course that immediately follows student teaching, while undergraduates do not. This course ensures that ISU SSTEP graduate students’ last experience in their preservice program is consistent with ISU SSTEP goals and habits. Something akin to this should be available for undergraduates following graduation.

3. *To the extent possible, work to ensure cooperating teachers understand and promote goals and habits in line with ISU SSTEP.* All teacher education programs have a limited supply of cooperating teachers. While not all cooperating teachers made be models of what the ISU SSTEP promotes, they should at the very least not be diametrically opposed to such goals and habits. Perhaps ISU SSTEP should provide a workshop for cooperating teachers that addresses the goals and habits promoted in the program, and the expectations for student teachers.

4. *Ensure that student teacher supervisors are knowledgeable of the goals and habits promoted by ISU SSTEP.* The incident where a ISU SSTEP student teacher was advised by his supervisor to stop using wait time may indicate a more pervasive mismatch between the program and university supervision. The only way to ensure that student teachers are advised in ways consistent with the ISU SSTEP is to have a better selection process when identifying supervisors. ISU SSTEP should provide a supervisor workshop that makes clear the goals and habits promoted in the program, and the expectations for student teachers.

5. *Implement an online forum for all graduates to communicate with each other and to revisit ISU SSTEP strategies.* Regardless of how well the ISU SSTEP prepared
graduates, other external factors can have a negative impact on inservice teachers. Teachers need a forum through which they can dialogue with others, share ideas, review materials from their ISU SSTEP experiences, learn of recent events in science education, and seek new ideas. The Internet is a viable solution due to its ease of access and wide availability. It is recommended that the ISU SSTEP set up and maintain such a resource.

6. *Work with science departments on campus to create science content sections designed for secondary science teachers.* Some study participants noted that their university science content courses did not model practices promoted by the ISU SSTEP. Participants sought a closer alignment between these science courses and the teaching methods promoted and modeled in the ISU SSTEP. While the ISU SSTEP science methods courses model goals and habits in the context of biology, chemistry, and physics, the overwhelming experience of preservice teachers in their non ISU SSTEP course work is inconsistent with the goals and habits promoted in ISU SSTEP. Much research exists that teachers teach as they themselves were taught. Improving post-secondary science content instruction has been argued to be a necessary step to improve secondary school science teaching.

7. *Pre-screen candidates for dispositions incongruent with the ISU SSTEP.* The ISU SSTEP cannot meet the needs of every individual seeking science teaching licensure. There are some individuals who are not receptive to the habits advocated by the ISU SSTEP. If such individuals could be identified prior to entering the ISU SSTEP, it would benefit the individual, the ISU SSTEP cohort, and science education faculty. It is recommended that such a screen process be developed and implemented.
This study investigated six graduates of the ISU SSTEP to determine to what extent the habits promoted and modeled in the ISU SSTEP transferred out into the graduates’ practices. The results obtained comparing graduates of the former and current ISU SSTEP were inconclusive. This was expected, taking into consideration the small sample size. This study was not expected to result in general conclusions regarding the ISU SSTEP. Instead, this study’s data will be pooled with other similar studies, and together will provide the data needed to assess the effectiveness of the ISU SSTEP.

While this study did not offer any overall conclusions about the effectiveness of the ISU SSTEP, its contribution lies in identifying confounding variables beyond the ISU SSTEP that impacts how the program’s goals and habits transfer into its graduates’ pedagogical practices. Several such confounding factors were proposed and discussed. Future studies will need to identify and account for these confounding factors in an effort to determine to what extent they promote or inhibit the transfer of its promoted goals and habits into graduates’ teaching.
REFERENCES


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>General Descriptor of Session</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 reflective of NSES</td>
<td>• Explored central issue activity</td>
</tr>
<tr>
<td></td>
<td>• Consolidated ideas and promoted sense-making</td>
</tr>
<tr>
<td></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 reflective of NSES</td>
<td>• Encouraged public discussion of idea</td>
</tr>
<tr>
<td></td>
<td>• Provided time for private reflection</td>
</tr>
<tr>
<td></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 reflective of NSES</td>
<td>• Teacher displayed understanding and confidence</td>
</tr>
<tr>
<td></td>
<td>• Science presented as dynamic, inquiry, conjecture</td>
</tr>
<tr>
<td></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 reflective of NSES</td>
<td>• Encourage students to generate ideas, questions, conjectures and propositions</td>
</tr>
<tr>
<td></td>
<td>• Intellectual rigor, constructive criticism, challenging ideas and supportive help</td>
</tr>
</tbody>
</table>
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

<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>
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<td></td>
<td></td>
</tr>
<tr>
<td>1. Lectures or gives directions</td>
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<tr>
<td>2. Makes statement or asks rhetorical question</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Initiatory (questioning)</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3. a) yes/no question</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) short-answer question</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) thought-provoking short-answer question</td>
<td></td>
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<tr>
<td>4. Extended-answer question</td>
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</tr>
<tr>
<td><strong>Responding (teacher-centered)</strong></td>
<td></td>
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</tr>
<tr>
<td>5. Rejects student comment</td>
<td></td>
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<tr>
<td>6. Acknowledges student comment</td>
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<tr>
<td>7. Confirms student comment</td>
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<tr>
<td>8. Repeats student comment</td>
<td></td>
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<tr>
<td>9. Clarifies or interprets what student said</td>
<td></td>
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</tr>
<tr>
<td>10. Answers student question</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Responding (student-centered)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11. Asks student to clarify or elaborate</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>12. Uses student question or idea</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Non-verbal Behaviors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. a) Inappropriate wait-time I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Inappropriate wait-time II</td>
<td></td>
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<tr>
<td>14. Passive non-verbal behaviors</td>
<td></td>
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<tr>
<td>15. Annoying mannerisms</td>
<td></td>
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</tr>
</tbody>
</table>

* 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.
Teacher's Name: 

Date: 

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!

<table>
<thead>
<tr>
<th>Item</th>
<th>Very Little</th>
<th>Little</th>
<th>Moderate</th>
<th>Much</th>
<th>Very Much</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convey self-confidence and a positive self-image.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Use critical thinking skills.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Convey an understanding of the nature of science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Identify and solve problems effectively.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Use communication and cooperative skills effectively.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Actively participate in working towards solutions to local, national and global problems.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Be creative and curious.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Set goals, make decisions, and self-evaluate.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Convey a positive attitude about science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Access, retrieve and use the existing body of scientific knowledge in the process of investigating phenomena.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate deep understanding of science concepts rather than mastery of many insignificant/isolated facts.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate an awareness of the importance of science in many careers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>1</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>not at all</td>
<td>very strongly prepared me</td>
<td></td>
<td></td>
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</tbody>
</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 teach?

Indicate below how well you feel your general education courses prepared you to teach.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
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<th>9</th>
<th>10</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>not at all</td>
<td>very strongly prepared me</td>
<td></td>
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</tbody>
</table>

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.

<table>
<thead>
<tr>
<th></th>
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<th>5</th>
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<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>not at all</td>
<td>very strongly prepared me</td>
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</tbody>
</table>

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.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
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<th>4</th>
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<th>6</th>
<th>7</th>
<th>8</th>
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<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>not at all</td>
<td>very strongly prepared me</td>
<td></td>
<td></td>
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</tbody>
</table>

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.
> About 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?
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BIOGRAPHICAL SKETCH

Joseph Taylor is a native of Marion, Iowa, a warm, lively community in east central Iowa. Upon graduating from high school, Joe trained with the U.S. Army Reserves and then attended Iowa State University. While studying at Iowa State, Joe served as the Chemistry Club president for two years, chaired the Union Drive Association Board of Review, and enthusiastically served with the Fellowship of Christian Athletes. Joe graduated with a Bachelor of Science degree in Biology with minors in German and Philosophy. Joe took a position as a full time substitute at Ames High School while concurrently pursuing a Master of Science degree at Iowa State University. During his studies, in the fall of 2003, Joe was mobilized with the 308th Quartermaster Company, Washington, Iowa, in support of Operation Iraqi Freedom. His unit was stationed at Logistics Base Seitz in Southwest Baghdad, Iraq, near the Baghdad International Airport for one year. Joe returned to American soil in March 2005, and resumed his studies. In June 2006, Joe married his most treasured friend, Jessica, and they moved to Coralville, Iowa.

This thesis brings to close a lengthy period of formal education at Iowa State University spanning from spring 1996 to summer 2007. During this final chapter Joe worked as a teaching graduate assistant, teaching elementary science teaching methods, and received the Iowa State University Teaching Excellence Award.

Each of us is like a vessel, empty until others enter our lives and fill us with their knowledge, love, and companionship. In the fall of 2006, Joe entered the public school system as a secondary science teacher to begin a new journey of filling the vessels of our youth.