Constructivist learning environments inviting computer technology for problem solving: new junctures for female students

Sally Rapp Beisser
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Constructivist learning environments inviting computer technology for problem solving: New junctures for female students

by

Sally Rapp Beisser

A dissertation submitted to the graduate faculty in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY

Major: Education
Major Professors: Ann D. Thompson and Camilla Persson Benbow

Iowa State University
Ames, Iowa
1999

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This is to certify that the Doctoral dissertation of

Sally Rapp Beisser

has met the dissertation requirements of Iowa State University

Co-major Professor

Co-major Professor

For the Major Program

For the Graduate College
DEDICATION

From beginning to end, this document is dedicated to my family without whose love and encouragement, the completion of my Ph.D. would have been unrealized.

To my late parents, Alvin L. Rapp and Betty Rapp Tuttle, I acknowledge a childhood filled with books, passions, goals, and faith. They would have celebrated my graduation day.

"To think is easy. To act is hard. But the hardest thing in the world is to act in accordance with your thinking." Goethe

To my husband, Kim Beisser, I offer heartfelt gratitude for his enduring support in my pursuit of intellectual challenge and accomplishment. His willingness to sacrifice time and convenience for my work has been a wonderful life gift.

"Seek first to understand, then to be understood."

To my daughters, Andrea Beisser and Sarah Beisser, I share my appreciation for their strong character, indomitable spirits, and hearts of gold. Their curiosity, questions, and compassion reinforced me throughout these years of study. May their lives be filled with books, passions, goals, and faith.

"To be a child is to know the gift of life,
To have a child is to know the gift of living."

I hope this document brings credit to Iowa State University, a place where I've loved to learn.

"We must not cease from exploration. And the end of all our exploring will be to arrive where we began and to know the place for very first time." T.S. Eliot
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ABSTRACT

While complex problem solving has been traditionally an area in which females have not excelled, there is increased emphasis in the development of problem solving for all learners in the Information Age. Concern exists regarding the gap between male and female competencies in using computer technology. Therefore, the possibility of intervention using computer technology as a tool for learning holds promise for females to develop competencies necessary to become better problem solvers. Interventions assisting female students in using technology to restructure or alter their conceptions of problem solving may prove to be effective in developing of problem-solving skills and computer use strategies. In a series of three articles designed to institute new junctures for females to use computer technology for problem-solving, this research suggests constructivist learning environments invite effective use of technology. The first paper chronicles existing computer technologies in American education making the case that invention, policy-making, and administration of educational leadership are provided predominantly by men in government, military and higher education. This study explores the development of technology in school practice and the role of women influencing these changes. The second paper, a concise literature review of problem solving, describes theoretical implications of problem solving with attention to learning environments where educational computing using multimedia technology is used to develop problem-solving skills. Impact of student motivation, attribution, self-efficacy, and self-regulation on problem-solving is amplified through the voice of gifted adolescents. The third paper, the result of a research study of gifted adolescent students using multimedia technology, advances the importance of females using computers for problem solving activity. Moreover, this paper describes an "engendered" adolescent computer culture limiting full participation of females in computer-related experiences. Appendices contains relevant research materials plus an accompanying CD-ROM containing raw data from individual and focus group interviews, e-mail communications, and evaluations of student work.
CHAPTER 1. CONSTRUCTIVIST LEARNING ENVIRONMENTS INVITING COMPUTER TECHNOLOGY FOR PROBLEM SOLVING: NEW JUNCTURES FOR FEMALE STUDENTS

General Introduction: A Series of Three Papers

Problem solving is a complex phenomenon that requires students to develop and integrate theoretical understandings of facts and processes with critical thinking skills in order to apply their knowledge to solve specific problems. Complex problem solving (especially in mathematics and science) has been traditionally an area in which many females have not excelled (Sutton, 1991; Meece & Eccles, 1993; Shashaani, 1993). Given the increased importance in the development of problem solving for learners in the Information Age, there is concern about the existing gap between male and female competencies in using computer technology (Arch, 1995; AAUW, 1998). The possibility of intervention using computer technology as a tool for learning holds promise for females to develop skills and processes necessary to become better problem solvers. It appears that one of the areas that computers may be most useful is in the area of complex problem solving (Jonassen, 1993; Jonassen & Grabowski, 1996). Interventions assisting female students in using technology to restructure or alter their conceptions of problem solving may prove to be effective in developing of problem solving skills and computer use strategies (Fulton, 1997; Ching, Marshall, Kafai, 1998; Kafai, Marshall, Ching, 1998).

Important to female accomplishment is the use of computer technology in a supportive learning environment encouraging higher level thinking, investigation, problem solving, and reflection. Because developing familiarity and facility with computers is an important educational goal for all students, schools need to ensure equity in computer use, access, and outcomes. While American classrooms have increasing numbers of computers available to students, it is unlikely that comparable numbers of classrooms encourage learners to engage in sophisticated levels of use of computers, particularly female students. Hence, this dissertation
research is a series of papers designed to increase understanding of the development of educational technology, problem solving theory, effective use of computers in a constructivist learning environment, thus influencing problem solving potential of the learner.

Educators and policy makers may benefit from an account of the chronological development of hardware and software in educational settings beginning with uses in government, military, and higher education. Support for educators using computers for problem solving is more likely if they can conceptualize theoretical information about problem solving and can apply concepts in the context of classroom curriculum. Roles of females as leaders and learners in the classroom are paramount to the issues and findings in this study. The study suggests support of knowledge and strategies for teachers, especially the majority of female teachers in American classrooms, to use technology in meaningful ways to challenge student's reasoning and problem solving skills. In that female students have been traditionally underchallenged in their understanding and use of educational technology, the study proposes successful ways in which females may reach their potential as learners and scholars of the twenty-first century.

Dissertation Organization

The first paper in the series of articles, Chapter 2, chronicles existing computer technologies in American education that rely heavily on invention, policy-making, and administration of educational leadership provided predominantly by men in government, military and higher education. In that the uses of educational technologies currently depend largely on implementation in classrooms led predominantly by women, this paper explores the chronological development of American educational technology, the impact of technology on school practice, and the lack of women influencing these changes over time. The initial paper on historical and gender issues is followed by a bibliography.
The second paper, Chapter 3, reviews the problem solving literature with particular attention to individual dispositions and learning environments with the potential to enhance problem solving activity. The literature review summarizes relevant research on problem solving and learning theory. Studies cited in this review range from early 1900s to late 1990s. Individual dispositions such as motivation, self-efficacy, self-regulation, strategy-use are discussed as they relate to problem solving. Learning environments that invite problem solving, such as constructivist, optimal, anchored, or situated learning environments are examined. Subsequent to presenting the theory of problem solving in appropriate environments is the argument is that multimedia technology has the potential to influence students' problem solving facility. Problem solving instruction is highlighted through the voice of 8-11th graders, predominantly females, enrolled in a multimedia technology summer course specifically designed to develop student problem solving skills. The second paper, reviewing the literature, is followed by a bibliography.

The third paper, Chapter 4, advances the experience of females using computers for specific problem solving activity. Sections within this paper include the statement of the problem, purpose of the study, research questions, methodology procedures, data analysis, verification, and conclusions. This paper primarily describes perspectives of gifted adolescent females using computer technology in and out of the classroom, including student views of peers, parents, and teachers using technology. Moreover, this paper describes an "engendered" (Gilligan, 1993; Lindsey, 1997; Bloom, 1998) adolescent computer culture limiting full participation of females in computer-related experiences. The paper is the result of my doctoral research study conducted during the summer of 1998 at Iowa State University during an Opportunities for Gifted and Talented (OPPTAG) Multimedia Mania EXPLORATIONS! class. Twenty students in grades 8-11 enrolled in the multimedia course through a precollegiate program for gifted students. This course attracted an unlikely majority of females due to planned interventions to invite girls to enroll. Interventions included mass
mailings describing the course, as well as full scholarship support for four female students enrolled in the course. There was a 3:1 ratio of female to male participants in the multimedia course. Students learned and applied problem solving skills in the development of a multimedia project in a self-determined area of interest. The study examined the differences in perceptions of females and males using computer technology in and out of the classroom, with particular attention to and interpretation of the female experience using computers.

Concluding arguments in Chapter 5 appeal to a larger audience in order to inform educators, teacher educators, and families of strategies and factors relative to female use of computer technologies as tools to facilitate their accomplishment. A bibliography follows the text in this final chapter. The three papers are presented in the following sequence:

I. THE COMPUTER GENDER GAP: A CHRONOLOGY OF EDUCATIONAL COMPUTING IN AMERICAN CLASSROOMS AND THE LACK OF FEMALE VOICE

II. PROBLEM SOLVING AND EDUCATIONAL COMPUTING: A REVIEW OF LITERATURE AMPLIFIED THROUGH THE VOICE OF ADOLESCENT STUDENTS

III. GIFTED ADOLESCENT FEMALES' PERSPECTIVES USING COMPUTER TECHNOLOGY

Following the final chapter, Appendices contains tables, figures, and all relevant materials in the preparation of the Multimedia Mania EXPLORATIONS! summer course and for the completion of the research study. In addition, there is an accompanying CD-ROM that includes 242 pages of raw data collected from individual interviews, focus group interviews, follow-up e-mail communication with the respondents, and instructor reviews of student work during the Multimedia Mania 1998 summer course.
References


CHAPTER 2. THE COMPUTER GENDER GAP: A CHRONOLOGY OF EDUCATIONAL COMPUTING IN AMERICAN CLASSROOMS AND THE LACK OF FEMALE VOICE

A paper submitted to the Journal of Information Technology for Teacher Education (JITTE)

Sally R. Beisser

Abstract

Historically, computer technologies in American education rely heavily on invention, policy-making, and administrative leadership provided predominantly by men in government, military and higher education. However, use of technology in the schools currently depends largely on implementation in classrooms primarily led by women educators. This paper describes a brief historical overview of the development of American educational technology, the impact of technology on school practices, and the role of women using computer technology in society. Specifically, the dearth of women is questioned in both the historical context of developing technologies and in female achievement using technology. The disparaging computer gender gap, continuing to distance females from the workforce to the classroom from full participation using technology, is addressed in the final section with concluding recommendations to enhance female potential.

Introduction

As computers become increasingly prevalent in schools and classrooms, there are heightened expectations for teachers to use new hardware and software for instructional purposes in meaningful ways. Teachers are constant decision-makers with the ability to influence an appropriate course of action about planning and instruction (Shulman, 1987). Staff development and teacher-educator initiatives include actions and processes to improve teachers’ skills, attitudes, understandings, and performance with successful implementation of
innovative practice. If such initiatives are to include effective use of technology, teachers must become proficient using new technology, as well as new instructional strategies. They must acquire new skills and knowledge, then augment their existing curriculum, classroom management, and instructional strategies. Fullan (1992) depicts these points as features of a dynamic system, each interacting with the "teacher as learner" integral to classroom and school improvement. Use of technology engages the teacher as learner in order to implement computer technology skills and concepts within established learning contexts.

Because developing familiarity and facility with computers is an important goal for all students, schools must ensure equity in computer access, use, and outcomes. Gender inequalities, impacting girls use of computers in the classroom, however, limit full participation by female students. Literature on women’s studies suggests that girls define themselves through social interaction, connecting, and communicating with others more so than boys do (Gilligan, 1993). Therefore, girls may experience use of computers differently than males. They may regard computers as tools for social interaction, connection, and communication. Furthermore, the U.S. Office of Educational Research and Improvement (1994) reports gender stereotypes include low teacher and parent expectations in mathematics, science, and technology. Bailey (1993) summarized the current status of research on gender-equitable treatment of students in American schools as far from being equal. Therefore, it should be no surprise that females report their experiences with respect to technology as different from their male counterparts (Benston, 1998). While the computer has no inherent bias, Turkle (1988) finds the "computer culture is not equally neutral," in that the social construction of the computer is a "male domain" (p. 41). Reis (1987, p. 83) in "We Can’t Change What We Don’t Recognize," reasons that educators, parents, and decision-makers are unable to change what they do not perceive. This paper, then, may increase understanding of an "engendered" computer culture limiting full participation of females in both the educational setting and the workplace.
Achieving gender equity with respect to computers and learning is a big challenge requiring commitment and effort of many players—teachers, teacher educators, educational leaders, parents, peers, software developers, educational researchers, and gender equity program developers—in order to promote an equitable climate for computer use in schools (Mark, 1992). In addition, equity in learning with computers requires attention to a number of factors such as access, learning context, instructional use, role models, parent and peer interaction, as well as individual student perceptions. Little information exists on understanding the history of educational technology or the important role of women as part of the dynamic web of systems responsible for the change and improvement of the current status of our schools worldwide.

Methods and Materials

Research data for this paper was drawn from research journals, historical books, legal documents, statistical abstracts, and annals in computing history. Document searches using ERIC (Educational Resources Information Center), PsycLIT (Psychological Abstracts), and Electronic Library® resulted in the collection of pertinent literature on gender, computer technology, and historical perspectives in educational computing. In addition, semi-structured interviews with three university-level faculty, four public school educators, and five public junior and senior high school students in the Midwest were conducted to gain insights about the development and influence of computer technology in specific educational environments. Respondents were selected as a nonrandom purposive group.

Participants, each interviewed once, represented three educational levels from elementary school to the university (see Table 1). Respondents representing elementary educators had varying degrees of experience using computers and other technology. They provided insightful life histories of how technology in education has changed within the 20 to 34-year span of their careers. University respondents, all females with varying levels of expertise using technology, were employed in a teacher education department with high
expectations to use and model technology in undergraduate and graduate instruction. Their responses focused on current professional activity using technology in higher education. Finally, the secondary students were competent, reflective teenagers from five different Midwest schools with varying experiences with technology in their school curriculum. Their voice provided a critical viewpoint, in that they were born 40 years after the invention of the computer. Semi-structured interviews, reported under assumed names, protected confidentiality of the 12 respondents.

Table 1. Description of Respondents

<table>
<thead>
<tr>
<th>Interview Respondents</th>
<th>Description of Members</th>
<th>Name</th>
<th>Gender</th>
<th>Age in Years</th>
<th>Years (approx.) of Experience using Educational Technology</th>
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<tr>
<td>University Faculty</td>
<td>3 faculty members</td>
<td>“Colleen”</td>
<td>female</td>
<td>32</td>
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<tr>
<td></td>
<td></td>
<td>“Paula”</td>
<td>female</td>
<td>52</td>
<td>22</td>
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<tr>
<td></td>
<td></td>
<td>“Carol”</td>
<td>female</td>
<td>55</td>
<td>7</td>
</tr>
<tr>
<td>Public School</td>
<td>4 educators</td>
<td>“Gene”</td>
<td>male</td>
<td>58</td>
<td>20</td>
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<tr>
<td>Educators</td>
<td></td>
<td>“Karen”</td>
<td>female</td>
<td>55</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Sheila”</td>
<td>female</td>
<td>53</td>
<td>20</td>
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<tr>
<td></td>
<td></td>
<td>“Susan”</td>
<td>female</td>
<td>45</td>
<td>19</td>
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<tr>
<td>Senior High School</td>
<td>5 secondary students</td>
<td>“Carl”</td>
<td>male</td>
<td>20</td>
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<tr>
<td>Students</td>
<td></td>
<td>“Dianne”</td>
<td>female</td>
<td>15</td>
<td>9</td>
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<tr>
<td></td>
<td></td>
<td>“Jack”</td>
<td>male</td>
<td>15</td>
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<tr>
<td></td>
<td></td>
<td>“Claire”</td>
<td>female</td>
<td>15</td>
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<tr>
<td></td>
<td></td>
<td>“Carrie”</td>
<td>female</td>
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Results and Discussion

The last sixty years of American invention and application of digital technology has produced changes that have grown exponentially. Computer technology has evolved from initial governmental and research purposes to instructional uses in the educational setting. In examining these changes one decade at a time, this paper describes the mushrooming use and influence of technology in education since America’s 1940s era of technical industrialization and invention.
1940s: The Invention of the Digital Computer

Computers were expensive inventions with specific purposes. Massachusetts Institute of Technology (MIT) researchers, for example, proposed a cost of $100,000 per month for an electronic computer to provide combat information on ships, radar, and sonar weapons for national defense (Davis, 1977). In the fields of science, engineering, industry, and mathematics electronic inventions were designed to improve military and governmental operations. Credit for the first digital computer in the United States should be given to John Vincent Atanasoff and Clifford Berry of Iowa State University (Burks, 1988; Mollenhoff, 1988) although they never received a patent due to an interruption in paperwork because of World War II. It was a forgotten invention for many years. However, in 1946 John Mauchly and Presper Eckert, using a design similar to Atanasoff and Berry, were recognized as the principal inventors of the Electronic Numerical Integrator and Calculator (ENIAC). A United States district court judge restored Atanasoff as the rightful inventor of the computer, in that Mauchly and Eckert had used Atanasoff’s design (Richards, 1966).

While military and governmental uses of computer technology preceded educational use, classroom teachers and students were unaware that within 50 years, a micronized version of this invention could influence educational reform in what would be known as “The Information Age.” Computers were operated in a male domain unless women were employed in government or military fields. However, Dr. Grace Murray Hopper, 1928 graduate of Vassar College with a Ph.D. from Yale University, was a female pioneer who made valuable contributions in the field of computer technology. Known as the “mother of computer programming,” she was a senior mathematician at Eckert-Mauchly Computer Corporation in Philadelphia programming the UNIVAC I, the first commercial electronic computer. Eventually, Remington-Rand took over Eckert-Mauchly as the company encountered financial difficulties (Carruth, 1991). Hopper, a commissioned U.S. Navy Rear Admiral, possessed technical vision to implement tools and techniques concerning vacuum tubes for arithmetic and
memory-switching functions. She developed COBOL, the first software language. The term computer "debugging" was coined while Hopper was hand-connecting UNIVAC cables when a moth was caught in the contacts of the relay wiring. After successfully removing the moth, the unit was "debugged," a term still used today (Hopper, 1988).

In 1940 only one-fifth of white women and one-third of black women were wage earners. Of those women employed, 60% of Black women, 24% of Asian, and 10% of white women were employed in domestic services (National Women’s History Project, 1998). However, with a massive government and industry media campaign in 1941, American women were encouraged to take jobs during WW II. As seven million women responded, two million women were employed as industrial “Rosie the Riveters” and 400,000 joined the military forces. By 1945 women industrial workers lost their jobs to returning U.S. service men, yet a survey indicated 80% wished to continue their productive work (NWHP, 1998). The few computer-related jobs in existence were held by men, (Statistical Abstract of the United States, 1960) yet women demonstrated competence in technical skill areas in industry.

1950s: Computers for Government, not for Schools

Growth of computer technology was moderate in the 1950s. In 1955 there were only 1,000 computers in the United States and 100,000 computer professionals (Davis, 1977). Computers, while not yet introduced for home or personal use, were reserved exclusively for governmental, industrial, and research purposes. Primary computer uses served military operations. The founder of “cybernetics,” technology social commentator, Norbert Wiener (1950) was convinced that a cybernetic environment of mutuality could control information. In the 1950s he predicted widespread use of computers in the next twenty years would affect blue collar and clerical workers. He was confident that individuals or groups would use the computational machine for “control of the masses.”

Educators in the 1950s did not conceptualize computers as either controlling or influencing the mass of American students. Typically, technology in the 1950s was used for
information dissemination or programmed instruction (Schrock, 1995). Equipment included projectors to operate 16mm black and white or new color films, stereophonic recordings on 78 and 45 rpm records, and 6-8” reel-to-reel audio tapes (Grun, 1963). Portable screens displayed film and overhead projector images. Overhead projectors, using transparencies for military instruction during WW II, became surplused machines. A new market using overhead projectors for instruction began in the schools. Similarly, opaque projectors were used to reflect and project nontransparent images. A principal recalls equipment in the 1950s.

"We used chalkboards (heavy slate blackboards) with dusty sticks of chalk. Calculations were achieved using slide rules, not calculators. Equipment for students included paper tablets, pencils in cardboard pencil boxes, rubber erasers, pens, and bottles of ink. The media center concept was yet to be developed making shared technical resources a part of the building environment, and certainly, computer or other technical terms did not appear on weekly school spelling lists, as they might now.” (Gene, male elementary principal)

Technology-related occupations were dominated by male invention and leadership. Women in the 1950s comprised nearly half of all system analysts and programmers (Lockheed, 1985), yet women in the general workforce earned only 63 cents for every dollar earned by males (NWHP, 1998). Women comprised 30% of the paid labor force in the 1950s. Men outnumbered women in higher education leadership and academic positions by a 3:1 ratio, while women outnumbered men in K-12 classrooms by more than a 3:1 ratio 1950 (Statistical Abstract of the United States, 1960).

Interest in computer technology, especially the development of communication technologies in the military, was growing. An event in 1956 sparked the beginning of what would be later called the “Internet.” The launching of the Russian Sputnik in 1956 motivated the United States to initiate the Department of Defense Advanced Research Projects Agency (ARPA) to maintain technological strength and guard against unforeseen intrusion from potential adversaries. Using ARPANET sites, researchers connected university computers across the country to exchange security information. Importantly, the goal of the network was to operate in the event of atomic warfare, thus government agencies could communicate.
Educators could not yet imagine the benefits of using networked computers for teaching, learning, and communication.

1960s: The Computer Punch-card Decade

Computers were used in higher education in the early 1960s. Integrated circuits of transistors and other electronic parts were on tiny slices of silicon chips. Computers were accompanied by paper punch cards to enter data. Data analysis took place at computer laboratories on campuses using room-sized mainframes. Elementary and secondary schools, however, had little access to emerging computer technologies. Elementary teachers recycled the soon-to-be obsolete computer punch cards for classroom flashcards because of their handy size (Interview with Sheila, fieldnotes, 1998). Desktop computer processing units were not yet invented, nor were computers conceptualized as tools for personal use. Instructional technologies for teaching were shared properties in buildings, not part of each classroom. Karen, a teacher in the 1960s, reflected on school technologies in her early career years.

“I ordered 16mm color films, 35mm slides, and filmstrips with printed scripts from the county superintendent’s catalog. Later, there were cassette tapes, but buildings had Wollensack® reel-to-reel tape recorders. Film, slide, and filmstrip projectors, record players even tape recorders, were shared items needing to be checked out in advance. Every room in the building was not equipped with an overhead, as they are now. We used opaque projectors to make bulletin boards. We ran off papers on blue line ditto machines and used a heat-processed machine to make ditto masters and transparencies. We didn’t have a central public address (PA) system, but used large hand-carried microphones for auditorium assemblies. Televisions in classrooms were supposed to be the upcoming new technology to improve learning. No one ever considered a phone, much less a computer, for communication in the classroom.”

Educational technology in the 1960s included commercial media sources such as content relevant filmstrips, color 16-mm film documentaries, emerging educational television, and network telecasting. Color television sets, while invented in 1953 (Grun, 1963), were not commonly found in schools and classrooms. Even with available black and white televisions, little research supported the effect of television on direct instruction and learning. Although teachers accessed television for classroom instruction, it did not seem to significantly influence teaching and learning.
Interest in the Internet was growing. The U.S. Department of Defense formed the Advanced Research Projects Agency (ARPA) to compete with the Soviets in technological development. Rather than centralizing computer resources, it was determined that a decentralized system of multiple connected computers, known as ARPANET, would have a better chance of surviving nuclear attack. First tested in 1969, the wide area network of computers linked government agencies and four universities (University of California at Los Angeles, University of California at Santa Barbara, University of Utah, and Stanford Research Institute). To improve public policy through research analysis, a network known as RAND (Research and Development) was developed to improve communication. Spearheaded by Paul Baran and other researchers, RAND allowed data transfer in nonsequential chunks. Telnet was established to allow a user to log on to a remote computer and File Transfer Protocol (FTP) allowed long-distance transfer of files from one computer to another (Franklin & Beedle Assoc., 1998). Advances in communication technologies were made predominantly by males, because most computer-related jobs of this era were held by men (Statistical Abstract of the United States, 1960).

Women employed in the 1960s, including educators, earned only 60 cents for every dollar earned by men while minority women earned only 42 cents for every dollar earned by men. In 1963, the Equal Pay Act (proposed twenty years earlier) was passed to establish equal pay for men and women who performed the same job duties (NWHP, 1998). During the Civil Rights Movement of the 1960s, the Equal Pay Act was initiated. The President’s Commission on the Status of Women, the Equal Employment Opportunity Commission (EEOC), the Affirmative Action Executive Order, National Organization for Women (NOW), and the Fifty State Convention on the Status of Women in Washington, D.C. were also initiated. National efforts from these organizations included equal rights, better hiring and employment practices, and social reform (Lunardini, 1997). Despite the emergence of empowering groups such as the Commission on the Status of women, EEOC, or NOW, there was little emphasis on female
representation in science, mathematics, or technology-related careers. Growing interest in education and women's issues concerned social consciousness-raising and the need for basic rights.

**1970s: Emerging Computer Literacy**

Few university women in the 1970s majored in computer-related areas of study compared to education. In 1971 there were 2,064 males earning a bachelor's degree in computer science compared to 324 degrees for women. There were 1,424 master's degrees conferred upon males in computer science compared to 164 females. Doctorates in computer science were earned by 125 men while 3 women did so (Statistical Abstract of the United States, 1974, p. 139). With education majors, however, the ratio was reversed with approximately 132,000 females receiving the bachelor's degree in education compared to 45,000 men. The trend weakened at advanced degree levels, however, where 49,000 females earned master's degrees in education compared to 39,000 males. Ultimately, males in the United States earned more doctorates as 5,000 men earned the highest degree compared to 1,300 women (see Table 2).

<table>
<thead>
<tr>
<th>Higher Education Degrees</th>
<th>Bachelor's Degree</th>
<th>Master's Degree</th>
<th>Ph.D. Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer Science Degrees</strong></td>
<td>2064 males</td>
<td>1424 males</td>
<td>125 males</td>
</tr>
<tr>
<td></td>
<td>324 females</td>
<td>164 females</td>
<td>3 females</td>
</tr>
<tr>
<td><strong>Education Major Degrees</strong></td>
<td>45,000 males</td>
<td>39,000 males</td>
<td>5000 males</td>
</tr>
<tr>
<td></td>
<td>132,000 females</td>
<td>49,000 females</td>
<td>1300 females</td>
</tr>
</tbody>
</table>


These statistics coincide with 1972 labor force occupational tables indicate that 85% of elementary teachers and 50% of secondary teachers were female while 17% of computer specialists were female (Statistical Abstract of the United States, 1984, p. 419). Computer science educational interest and career choices continue to be male-dominated (see Table 3).

Technology in the schools made advancements through improved educational television, public broadcasting networks, media resources on cassette tapes, video-cassettes,
Table 3. Occupations in 1972 in Computer Science and Education

<table>
<thead>
<tr>
<th>Occupations Held</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Sciences</td>
<td>83%</td>
<td>17%</td>
</tr>
<tr>
<td>Elementary Education</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>Secondary Education</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>


and touch-tone dialing in administrative offices (Interview with Gene, fieldnotes, 1998). If schools had computers, they were in administrative offices rather than decentralized in individual classrooms. Use of computers was primarily an administrative initiative. School secretaries were among the first school personnel to use computers for word processing. Ninety-nine percent of these positions were held by women (Statistical Abstract of the United States, 1984, p. 419). Computer access for classroom teachers, of either gender, or their students was yet to come.

“If I think back to then [late 1970s] there definitely were computers in the schools. Other than in central offices, there was only one [classroom computer] in our building, as in most others. Usually an upper grade male teacher was responsible for the computer in our building. He hardly had the time or inclination to instruct the rest of us. It was simply there in the classroom and most of the other teachers were glad we didn’t have to deal with it.” (Sheila, elementary educator)

The well-marketed Apple IIIE computers infused American schools and classrooms along with black/green monitors, drill and practice software, but little teacher-training. Available instructional software programs had limited classroom application. For example, computer software was used for remediation of slow learners and extension for gifted learners. At one end of the spectrum were drill and practice programs and at the other were complicated simulations, instructional games, and intelligent tutorial systems to challenge the gifted students who finished their work early (Means & Olson, 1994). Because of the narrow applicability, technology had little effect on daily teacher-directed activity with most students (Cohen, 1988).

Increased interest in technology was due largely to the invention of the microprocessor in 1971 (Caporael, 1984). The development of microprocessors made personal desktop computers possible. The “computer on a chip” encouraged diverse applications transforming
familiar objects, such as converting common office typewriters into word processors. Before 1975 there were fewer than 200 microcomputers in the United States. Many of those were built from scavenged parts by electronic enthusiasts. By 1977 there were approximately 20,000 personal computers (Logsdon, 1980). Emerging technologies were becoming more cost-efficient influences on teaching and learning, as well as potential instruments of educational reform.

One such emerging technology was the Internet, although this term was still not in use. Using ARPANET, a wide area network first used for governmental and military operations, the first e-mail program for personal messages was created in 1972 by Ray Tomlinson. In the following year, the first international connection linked ARPANET to the University College of London and the Royal Radar Establishment in Norway. Even Queen Elizabeth II posted her first e-mail message in 1976. Rival networks, BITnet (Because it's Time Network) and CSnet (Computer Science Network), soon after emerged in order to expand network services to other universities. In 1979, Usenet newsgroups were established as a public network in which participants exchanged information and posted messages to a group (Franklin & Beedle Assoc., 1998).

**Early 1980s: Computers as Instruments of Educational Reform**

While sales of personal computers increased despite the short supply of integrated computer chips, prices of computers declined. IBM introduced a personal computer in 1981 (Carruth, 1991). In 1982 there were approximately 2.8 million personal computers sold in the United States with only 18% of the nation’s schools using computers for instructional purposes (Caprael, 1984; Mehlinger, 1996). The explosion in access to computing technology created a new constituency of educators interested in the social effects of technology and educational computing (Reflections from Gene, fieldnotes, 1998).

Uses of computer applications in the 1980s included information retrieval, mathematical calculation, manipulation of mathematical models, simulations of experiments, and problem
solving associated with computer-assisted learning (Hills, 1982). Computer availability included mainframes with suitable terminals. However, few personal computers were used in the schools. Novelty microcomputers were available at colleges and universities providing flexible and individual computational uses rather than institutional data base management.

Seymour Papert (1980) introduced *Mindstorms*, a seminal book in which he summarized that radical change in education was possible using technology as a tool for thinking and learning. Papert conceptualized change in reasoning and skill development in direct relation to the impact of the computer in education. For instance, Papert differentiated between the knowledge and learning. Knowledge, he stated is a commodity like money to be earned and placed in a bank depository until needed. Conversely, learning is a process of discovering and making meaning of a set of ideas.

According to Naisbitt (1982) in his 1980s trend analysis book, *Megatrends*, new mass technologies tend to evolve through three stages. In the first stage, a new technology follows a "line of least resistance," into a prepared market. At the second stage, users "improve or replace previous technologies" with the new technology. Finally, in the third stage, users discover "new functions" for the technology based on its potentials discovering that which was not possible before. Similarly, technological advancements of the computer have evolved in the U.S. with education markets poised in the 1980s to incorporate technology into the learning environment. For example, educators replaced 16mm film reels with 1/2" video cassettes while computer word processors replaced manual and electric typewriters. Eventually computers were no longer restricted to military and governmental operations. Schools examined potential benefits from emerging technologies. In the late 1980s computers were viewed as new discoveries for learning (Peck & Dorricott, 1994). Perhaps, this period of time parallels Naisbitt's third stage of influence where "new functions" of technology discovered that which was not possible before.
Further, in early 1980 the term “Internet” was coined to define a “connected set of networks” and domain name systems (DNS) were introduced to allow organizations to associate easy-to-remember network names such as npr.org (an organization) or ibm.com (a commercial corporation) or isu.edu (an educational institution). Various sets of protocols were developed over the next nine years, leading to the standard set of protocols called Transmission Control Protocol/Internet Protocol (TCP/IP). By 1984, there were “some 1,000 computers” connected to the Internet and in 1996 there were an estimated “several billion users” (Poole, 1997, p. 208).

Interestingly in the 1950s and 1960s, computing was considered an ideal occupation for women. It was “clean,” did not involve manual labor, and could be conducted from home (Linn, 1985). While women comprised almost half of all system analysts and programmers, by the 1980's they comprised only one fifth (Lockheed, 1985). Is it possible that computer technology was becoming a lucrative field attracting more males than females? In a survey of 17 and 13-year-old students, Collis (1985) found that although the majority of girls believed in the abstract that they could be as competent with computers as boys, when the question concerned themselves as individuals, this confidence decreased. Girls believed that other girls were as good at computers as boys were, yet they did not believe that they personally fit into this category.

Edwards (1990) suggested that many women of the 1980s avoided computing due to the historically military focus of technology in this country and the male fascination with defense. Indeed, the more information technologies were linked with defense (as in computer war games) and with the engineering and science domains, the more girls tended to distance themselves. As information technology grew explosively, girls and women needed to become technologically proficient, if for no other reason than to increase their earning potential (Gaines, Johnson, & King, 1996).
**Mid-1980s: Computer as a Productivity Tool**

Computers in the mid-1980s were electronic devices to accept data, apply word processing procedures, and supply the resulting data in a form suitable to the user (Ellington & Harris, 1986). Officials at IBM announced that newly manufactured computers, using the megabit memory chip, were capable of storing more than one million bits of electronic data (Carruth, 1991). The computer industry was booming.

Computers were more prevalent in the schools where computer-assisted learning (CAL) was introduced as an integral part of the instructional system to engage learners in "real-time interaction" for computer-managed instruction, learning, and training. In addition, computer implementation in most educational settings included word processing and data management in central offices by secretarial staff and administrators. Moreover, teachers and students in classrooms were using computers primarily for drill and skill remediation. Computers were not influencing novel ways of presenting instruction (Means & Olson, 1994).

Rather than using computers for improving efficiency and productivity in traditional ways, such as word processing instead of typing, Papert's seminal work (1980) with LOGO fostered unique applications of computers. Instead of merely doing more of what we have always done at a faster speed, Papert believed that computer use could influence logic and problem solving. For example, the LOGO language required students to use the computer as a tool for problem solving by discovery learning.

Sophisticated uses of the computer were not widespread in schools, however. As an example, software applications often included point and click features to prepare documents, signs or banners that were printed on perforated paper. One teacher was overly impressed.

"It wasn't until several years later, when I had my own computer with a software program called Printshop© for making signs, cards, and banners that I realized how easy it was to create these items. I was so impressed with the computer expertise of one of my third graders who created a sign for a poster presentation about Thomas Jefferson. I honestly thought the work that Brad [the student] created was the result of a complicated computer effort. I felt almost embarrassed to figure it out myself nearly a year later. It was effortless to create. I laughed out loud. That kid
must have thought I was crazy to rave about such a beautiful computer-generated sign on his president's poster!” (Susan, elementary teacher).

Information management and data handling using spreadsheets, Internet connected computer communications, and authoring software were not yet widely used in schools. Development of the Internet, however, bustled elsewhere. The National Science Foundation (NSF) established five supercomputing centers in 1986 and there were numerous new connections established at universities all over the world (Poole, 1997). The Internet Relay Chat (IRC) was invented to allow people to discuss topics on the Internet. Along with progress in communication technology soon came intrusive problems such as “Internet Worms,” “hacking,” and “cyberspies” influencing the formation of CERT, The Computer Emergency Response Team (Franklin & Beedles Assoc., 1998) to keep electronic communications secure. No one could imagine the explosive changes in technology drawing near in the next decade.

“I can’t imagine my life without a computer. I do not remember using one in grade school, but since high school I have built at least four computers. I spend at least 3 hours a day on the Internet, design Websites as a part-time job, and plan on a computer-related field when I graduate from college such as management of information services.” (Carl, male secondary student)

Late 1980s: School Reform and Technology

Initial 1980s reform efforts attempted improvement of student achievement by increasing academic course requirements and “back to the basics” instruction (Urban & Wagoner, 1996). Reformers did not, however, examine the way that teaching and learning unfolded (Means & Olson, 1994). Consequently, computers were introduced into conventional instructional environments where teachers did most of the talking and students completed well-defined content-specific tasks. Integration of technology did not change the teaching and learning process. There was a mismatch between pedagogy and the potential uses of technology. Knowledge was still traditionally organized, manipulated, and displayed, thus compromising the influence of computer technology. Educators commonly taught “about”
technology and not “with” technology. Perhaps, we have now crossed the “line of least resistance” in order to “improve or replace or improve previous technologies” (Naisbitt, 1982).

Administrators were encouraged to introduce hardware and software, along with staff development, to support faculty in using technology in teaching (Interview with Gene, fieldnotes, 1998). Eventually, meaning was attached to integrating technology in the classroom, yet systematic efforts to do so in most American school districts were limited. “Stand-alone technology,” using technology in ways that are disconnected from curriculum context, was no longer acceptable or desirable in either teaching or learning.

“I am glad teaching with technology is finally linked to the curriculum. Years ago, I grew tired of having to attend workshops to learn programs that made absolutely no sense with what we were teaching in the classroom.” (Sheila, elementary teacher)

The Apple Classrooms of Tomorrow (ACOT) research studies found that learning with computers does not result in learning in isolation (Dwyer, 1994). Use of technology, as previously thought, did not isolate children at their computer monitors, but allowed learners to interact in meaningful ways for significant periods of time. For example, work with computers in cooperative pairs or groups of students could improve both social and academic growth.

Because of technology, student products were becoming more polished. Technology added authenticity to traditional school tasks such as writing themes, constructing reports or creating flyers, banners, communication documents, and student-generated products. Students took pride in using the same tools as practicing professionals. Carl, a high school student, who used computer technology for homework and musical composition, said:

“I knew jazz musicians who were envious of the cool technology we had available just for our high school music class. Our school is small, but we had great computer equipment and software. We didn’t have computer programming or computer assisted design (CAD) classes in our school, though. I had to figure that out on my own. But I learned to build my own networked computers. I’ve built several. I am on my fifth computer now. I use the Internet daily.”

Carl, like other Internet users, communicated in a networked environment no longer restricted to the ARPANET agency, which eventually was decommissioned in 1990.

Throughout the world, the electronic frontier was commercially available and accessible to
millions of people. Freedom of speech was protected on the Internet through the Electronic Frontier Foundation (EFF) provided the first dial-up Internet access (Franklin & Beedle Assoc., 1998). Communicating, as well as learning at a distance, was common.

Distance education courses throughout the 1980s evolved as broadcast video and telecourses to address goals of independent learning. Major telecourse developments were funded through in the late 1980s by the Annenburg Foundation, the Corporation for Public Broadcasting, and some universities (Davey, 1999). In these courses, little interaction took place between the instructor and students. Hence, synchronous two-way, interactive video systems allowed a teacher to be in one location with students at multiple locations. Sites were interconnected through audio and video networks for students at each site to see and hear the instructor and vice versa. Interactivity of all participants was possible. As a result, a distance course could connect diverse learners, cost less money, and support the goals of independent learning (Berenfeld, 1996). Linking instruction and interaction, communication technologies changed the way people exchanged thoughts and ideas.

Despite claims that technology might improve communication skills or learning, not all critics agree. Clark’s controversial research summarizing nearly 70 years of research states,

The current evidence is that media are mere vehicles that deliver instruction, but do not influence student achievement any more than the truck that delivers our groceries causes changes in nutrition. Only the content of the vehicle can influence achievement (Clark, 1983, p. 445).

Clark suggested research on educational media should not seek to discover which medium is best, but rather should focus on more appropriate independent variables that may effect learning and communication. Specifically, he suggested that educational media research should examine the effectiveness of different instructional approaches to advance reasoning. Because students use the computer doesn’t mean they are learning, he argues. The following decade held promise for computer technology to influence school reform through improved use of computers for communication and achievement.
Early 1990s: Increased Popularity of Computers in Education

The 1990s was a decade of increased computer popularity in schools with heightened awareness of potential influence on learning (Dyrli & Kinnaman, 1995). Yet opportunities to improve learning were largely underdeveloped because pedagogical strategies and practices were not learner-centered (McCombs & Whisler, 1997). To improve learning, use of emerging hardware and software must be incorporated in problem-based, authentic learning environments to invite the most powerful applications of computer technology in the school setting (Dede, 1995).

One powerful example using the computer in education was Margaret Riel’s (1992) work with cooperative-learning techniques using a computer network to involve teams of at-risk inner city learners separated by physical and social distances. By participating in Learning Networks (Riel, 1993), students were able to define themselves for other students who lived in distant regions, and through this relationship, form new understandings of themselves. Teachers, involved in networked cooperative learning circles, reported that they developed new instructional strategies and increased their self-esteem (Riel, 1990).

Another example of computer use in education is the creation of student products using multimedia and hypermedia technology to import graphics, sound, text, and animation with Hyperstudio®, Digital Chisel®, m-Power®, or PowerPoint® programs. Students could integrate images from CD-ROMs and the Internet. They could scan graphics from multiple print sources. Student’s decision making skills increased through sustained effort using multiple indicators to organize and to produce information. Creativity skills were enhanced through visual and organizational presentations of concepts and ideas (Dyrli & Kinnaman, 1995). Videoconferencing using applications such as CU-SeeMe® made possible two-way visual-audio communication.

While technology involvement in schools increased, the gender gap in technology-oriented careers and higher education persisted. In higher education, more women than men
majored in education. Men dominated computer-related careers. For example, during the 1990s, the percent of females in education (excluding college and university) increased to 75%. Women employed in computer science occupations was reported as 30%. However, 82% of computer data entry jobs were held by females. The percentage of females holding jobs as secretaries, stenographers, and typists was reported as 98% (Statistical Abstract of the United States, 1998, p. 417-418). (See Table 4.)

<table>
<thead>
<tr>
<th></th>
<th>Education</th>
<th>Computer Science</th>
<th>Secretarial</th>
<th>Data entry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Males</strong></td>
<td>25%</td>
<td>70%</td>
<td>2%</td>
<td>18%</td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td>75%</td>
<td>30%</td>
<td>98%</td>
<td>82%</td>
</tr>
</tbody>
</table>


It is not surprising that computer degrees in higher education were predominantly conferred upon males. For example, in 1995, males earned 71% of Bachelor degrees, 74% of Master’s degrees and 82% of Ph.D. degrees in computer and information sciences (National Center for Education Statistics, 1997, p. 272). (See Table 5.)

<table>
<thead>
<tr>
<th></th>
<th>Bachelor</th>
<th>Masters</th>
<th>Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Males</strong></td>
<td>71%</td>
<td>74%</td>
<td>82%</td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td>29%</td>
<td>26%</td>
<td>18%</td>
</tr>
</tbody>
</table>


The gender imbalance exists in the classroom. Research studies report that boys dominate ‘hands on’ and computer-related activities (Sadker & Sadker, 1994; Koch, 1994; Guzzetti, 1996; Beisser, 1997; Tarlin, 1997; Valenza, 1997). Many females believe that boys are better with technical toys, machines, tools, and electronics; therefore, males must be better at using computers. Females experience the computer culture as a male-dominated world where males seem more skilful using keyboards, monitors, computer processing units (CPUs), and software (Turkle, 1984; Turkle, 1986; Benston, 1986; Papert & Turkle, 1990;
McLester, 1998). Not all girls feel isolated from the computer culture, however. Dianne, a ninth grade student, explains her activity using computer technology.

"Well, most of my girlfriends just use the computer to play games, chat online, send e-mail and do reports. Sometimes my friends and I spend hours on the computer chatting or playing games during sleep-overs. My guy friends, who I guess you could say are computer nerds, program in Q-BASIC, play games, do research, crash peoples' computers, almost anything you could think of. One of them has his own online RPG [Role-playing game]."

Boys, who report they are "keyboarding" as opposed to "typing," feel there is "no equity problem" regarding gender (Benston, 1988). For them it is "no problem" because they take control, even unwittingly, when using computers for games, competitions, and peer-based computer projects in the school domain (Chen, 1986; Sutton, 1991; Kay, 1992; Shashaani, 1993). Inequality is furthered by gender socialization of boys who feel more positive about computers and computer classes, having more confidence using the computer, and seeing computers useful to them (Burstyn, 1993; Shashaani, 1993; Tarlin, 1997).

Failure to address gender disparity maintains a male hierarchy of control and dominance marginalizing girls who are more likely to ask for directions and accept assistance. One of the female teen-agers interviewed agreed. "Guys do a lot more programming and stuff. Girls tend to watch or check e-mail," complained Claire. One of the males, Jack, checks his e-mail, but uses 5 online alias chat names to communicate. He remarked that "computer programming is a guy thing because guys are expected to do that." While both are engaged with computer activities, it would seem Jack takes a more authoritative approach to using the computer.

Another female student Carrie, shares her perspectives on webpage development by indicating ways in which she would seek assistance to create a homepage.

"If I actually had the time to make a webpage, I'd ask my super-brain guy friend who sits behind me in Spanish how he did it. If he got too technical, I'd probably pick up a book about it, most likely a 'Homepages For Dummies' kinda thing."
Jack, on the other hand, sought assistance but in a more independent, self-directed manner. "Well, I actually learned most of my computer skills by getting them off the Internet. I just figured out how to write HTML. I learned it all myself on an Internet course."

Instructional technology of the 1990s, particularly multimedia and hypermedia applications where teachers don't "know all the answers," has helped teachers, both male or female, become active learners. Multimedia and hypermedia programs provide opportunities to explore content in nonlinear and nonsequential ways allowing learner control and use of information. The teacher's role becomes one of facilitator of the technological tool and of the content area. The challenge of planning and implementing technology-supported activities has provided a context in which an initial lack of knowledge is not a cause for embarrassment. As a result, teachers are eager to share their developing expertise and to learn from one another. As they examine their instructional goals, their curriculum, and technology's possibilities, they collaborate more, reflect more, and engage in more dialogue (Means & Olson, 1994).

Multimedia resources have redefined the concept of textbooks and opened a world of connections making electronic resources meaningful. For instance, the state of Texas issued "Proclamation 66," a landmark case in the history of educational technology (Texas Education Agency Chapter 66, 1996). This legislative act made it possible for Texas school districts to purchase instructional multimedia products with funds that previously were limited to the acquisition of standard textbooks. This act seemed to represent a breakthrough in thinking about what constitutes a textbook.

Instructional use of multimedia in a situated problem-based, problem solving learning environment provides an opportunity for learning where students work together to make decisions cooperatively and constructively to reinforce skills used in real world work environments (Blumenfield, Soloway, Marx, Krajcik, Guzdial & Palincsar, 1991). As a pedagogical strategy, both males and female students can cooperatively discuss ideas and interact with technology. Although hypertext media and systems for learning complex
knowledge have attracted recent attention, more research is needed to understand special characteristics associated with learning in nonlinear and multidimensional hypertext systems (Jacobson & Spiro, 1995).

Finally, effective uses of technologies include information management in authentic environments incorporating challenging tasks with appropriate curriculum. Thus, complex tasks challenge the conventional use of technology as well as the traditional time allotments for delivery of instruction, to achieve equal access and equitable use of the 1990s technologies.

**Mid to Late 1990s: Heightened Internet Development**

While schools budgeted considerable amounts of money on learning systems, many were dominated by drill and practice models of instruction. Dependence on this model reflected a dependence on commercially available software programs and traditional instruction. Advocates of problem-based approaches to learning oppose the extensive use of drill and practice systems. Instead they promote a problem solving, reasoning-oriented approach that engages the learner (Simon, 1980; Reed & Burton, 1988; Burstyn, 1993; Delisle, 1997). Commercially available educational software moved toward problem solving and away from the practice paradigm. Until recently, adults assumed that serious learning in school had to be unpleasant. Computer use in schools was justified because students enjoyed it. Being engaged in computers, however, does not mean that students are learning anything important from them (Woronov, 1997).

More significant than expansion of software, were developments of the Internet. In 1991, Linder and McCahill created “Gopher,” Tim Berners-Lee developed the first “code word” for the World Wide Web (WWW), and the Commercial Internet Exchange (CIX) was founded (Franklin & Beedle Associates, 1998). These three developments marked the explosion of available dial-up Internet access increasing the development of public data communications networking. An important paradigm shift using computers to engage students in the learning process embraced the explosion of networked computers through the Internet.
When only 20 years ago we had just four hosts of ARPANET connecting four research universities, we now have nearly 10 million hosts connected on the World Wide Web. The Internet connects educational institutions from elementary to higher education.

As a result, using the Internet for distance learning has become a beacon for extending opportunities for larger and more diverse numbers of learners to participate in higher education. Arguably, distance learning has always been possible through correspondence courses, independent study, educational radio first issued in 1921, or educational television licensure in 1945 (Neal, 1999). However, with the power and flexibility of advanced technology, distance education is valuable for course instruction at colleges and universities. The computer and networked communication technologies have provided college faculty and students with needed tools to incorporate the convenience of time and distance-free learning opportunities with effective instructional strategies. Thus, distance learning can incorporate student-to-student discussions; faculty-to-student inquiry, and effective feedback (Davey, 1999). As a result, almost every two-and four-year university in the United States has developed courses deliverable via the Internet as the primary communications vehicle. Western Governor's University [http://www.wgu.edu] is probably the most widely recognized "virtual university" in the U.S. created by pooling resources from various colleges, universities, and corporations. The Open University in England [http://www.open.ac.uk] has vigorously expanded its Internet learning opportunities and services. Others, such as Southern Regional Electronic Campus [http://www.odu.edu], have joined consortia, to provide distance-education courses (Neal, 1999).

Donald Ely (1995) states that nearly every school in the United States has computers and 75% of them have network capabilities. The student to computer ratio has increased from 1:75 in 1984 to 1:12 in 1994. Online computer networks have 13,500,000 users with a growing rate of 2000 users daily (Ely, 1995). Electronic exploration via the Internet connects students to endless sources of information and promotes communication. Navigating sites on
the Internet through use of searching and indexing tools, is a basic skill for students learning in the "Information and Communication Age." Using search engines such as Yahoo or Alta Vista, students browse for information. Using the computer as a production tool, students can retrieve and organize data. Students can become e-pals with children in another country, download data for projects and presentations, seek resources using the Library of Congress, chat with peers over Newsgroups or Netnews, or develop their own homepage.

According to the National Center for Educational Statistics (cited in Vojek), 65% of all U.S. public schools had access to the Internet in the fall of 1996. By January of 1997, over one million web sites were established. The number of sites is growing rapidly. Clearly there is increased access to networked computers in America's classrooms. Technology permits connections to information in ways before unimagined. Students develop connections to real world issues. Educators concerned about controversial material on the Internet need to refer to or establish acceptable use policies (AUP'S) for governing behavior at school." Offensive or uninvited sexual messages on the Internet are unacceptable (Kantrowitz 1994). Available "Netiquette" user guides provide guiding suggestions and support for wise use of networked technology (Rinaldi, 1996).

**Disparaging Gaps for Females**

As computers become commonplace tools in school and in the workplace, they have and will have substantial impact on women's lives. However, numerous studies have documented inequalities for females. A seminal study from the Laboratory of Comparative Human Cognition (1989) summarized the net effect of the "microcomputer revolution" in education as reinforcing and exacerbating previous inequalities of educational achievements of women and minorities. They support the idea that gender bias, ascribing mathematics and science as a male domain, may be mirrored in female use of technology. Another study indicates that more computers are in the hands of middle and upper class children than poor children (Leigh, 1997). Many studies verify that female students have less involvement with
computers than male students, irrespective of class or ethnicity (Hess & Miura, 1983; Hawkins, 1985; Hess & Miura, 1985; Chen, 1986; Cole, Griffin & LCHC, 1987, Levin & Gordon, 1989; Sutton, 1991; Kay, 1992; Burstyn, 1993; Shashaani, 1993; Kantrowitz, 1994, Tarlin, 1997). Instead of realizing a long standing dream of general increases in basic literacy as a result of children's involvement with computers in their classrooms, we seem to be continuing the case in which the "rich" are getting educationally richer and the gap between them and the "poor" is widening (Interview with Karen, fieldnotes, 1998).

Even when computers and opportunities to learn computer skills are accessible, females remain a minority. For example, Hess and Miura (1985) found in their study of summer computer-education camps, that boys were three times more likely to attend optional computer camps and classes, with variations increasing with grade level, program cost, and difficulty levels of the course. This means girls represented 28% of those attending the beginning and intermediate camps, 14% of advanced camps, and only 5% of high-level computer courses. Other researchers have focused on the prevailing male-oriented technology culture favoring male-oriented themes in computers games of violence and competition (Kiesler, Sproull, Eccles, 1985). "It's not a coincidence that one of most popular Nintendo products is called 'Gameboy'" (Tarlin, 1997, p. 21).

Because girls tend to use computers more frequently for word processing while boys are more often computer programmers, these experiences contribute to lower enrollments of females in computer courses and out-of-school computing (Mark, 1992). Girls are less likely to voluntarily participate in computer activity. Beyond equal access, factors such as psychological, social and attitudinal issues influence female use of computers.

The national standards movement has influenced integration of computer technology in the curriculum. Students are expected to develop skills deemed important according to educational standards. For instance, the National Council for the Social Studies (NCSS) includes a national standard for Science, Technology, and Society (1994). Students learn both
the history of technological developments and the application of technology in society. The McREL Institute Compendium of Standards and Benchmarks for K-12 Education, (Kendall & Marzano, 1998) summarizes K-12 national standards in technology. Learners should know the characteristics of computer hardware and operating systems, uses of computer software, and understand interrelationships of technology and society. New teachers must exceed basic skill levels in using computers. The combined power of The International Society for Technology in Education (ISTE) and National Accreditation of Teacher Education (NCATE) have contributed to successful endeavors to develop programs and promote change within the teacher education structure (Taylor & Wiebe, 1994).

Students are exposed to computer software perpetuating sexual and racial stereotypes from advertising instructional media, television, movies, and magazines. For example, in a study of nearly 1,500 graphic images of Macintosh® clip art (Brownell, 1993) minorities were underrepresented while whites were overrepresented, relative to the general population. Not surprisingly, women were underrepresented or cast in secretarial roles in the graphics. Men were disproportionately overrepresented in the computer software images.

However, women are not underrepresented in the education workforce. A 1997 profile of America’s teachers indicates women teachers still outnumber men by three to one. Nearly two-thirds of elementary teachers are women. Men teaching grades 7-12 outnumber women two to one. More than 90% of all United States teachers are Caucasian and 7.3% are Black. Teachers are better prepared to teach than ever before with almost 100% obtaining a bachelor’s degree and 56.2 with a master’s degree or higher. This is an increase from the 1970s when 85% of teachers had a bachelor’s degree and only 23% had a master’s degree (Edelfelt, 1997).

Despite a majority of women in education, research by Damarin (1990) suggests that technology has largely been developed “outside of domain of the teacher,” especially females. Damarin states that without the benefit of contributions of women educators in the development of technology, progress within the classroom is out of their control. Current research on
effectiveness of educational technology denies the importance of women's work, Damarin continues. Educational technology is thoroughly saturated with the sex biases of its root disciplines, science and mathematics. Both disciplines are curricular contexts where technology is valued. Excluding women from full participation in scientific, technical, and mechanical fields means that when women use technical tools and machines, they confront marginalization in a male-dominated technological society.

Paula, an African American assistant professor with a Ph.D. in curriculum and instructional technology, shared her perspective on equality. "Technology access was not as problematic as my lack of identity." Even in a previous career as a computer analyst, she was given limited recognition for her work. She reflected:

"Gender or racial discrimination was definitely there, and it wasn't necessarily subtle. The high visibility projects leading beyond middle management were handed to men. Getting in the door wasn't the problem. Minorities were valued. It was getting the challenging jobs behind that door that made the difference."

Technology in teacher preparation courses, however, encouraged student competence regardless of gender or race. Colleen, a female assistant professor of education reflected on her Master's degree preparation in the late 1980s.

"While my parents encouraged me to take computer classes, it was actually an education professor in my Master's program who made the difference. He took an interest in my work. The technology project I completed to illustrate a concept, ended up being an elaborate city skyline. Later I taught a graduate level course in computers."

Feminist scholarship is an active, dynamic process of rethinking and energizing (Damarin, 1990). When computer technology is relevant to the interests and concerns of women, the question of whether or not computers are less appealing for women than for males, is less important than the question of whether or not women find computers an effective tool in work and learning environments. Females excel in collaborative problem solving environments. Carol, a college faculty member, explained her appreciation of a faculty
technology mentorship program at her university. She was able to learn new skills using technology in higher education.

"I have concentrated on learning technology in my own way. I have kept a ‘computer mentoring journal’ to see if I apply everything I have learned. In the absence of threat, I was able to reduce stress to engage in new learning that was of benefit to my teaching immediately! This technology mentorship has helped me bridge that gap."

If technology is to be integrated in academic content to stimulate student thinking, decision-making, and problem solving, teachers need to be better prepared to instruct students using technology. As a high school student, Claire argues that classroom teachers lack skills using technology. When asked if teachers needed computer training, she exclaimed,

"YES! So many of my teachers, past and present, have had no idea how to use their computers!!!! (emphasis hers). They learn how to do grades and QuickMail but then request the students help for anything else! Teachers NEED to be more prepared for our technologically advancing world...especially those that have problems turning on the machine!"

Another student, Carrie, supported the need for more teacher training and sees students filling the role of assisting their teachers in using technology at school.

"I am in great support of teachers receiving more training. Often in my classes, the teacher will know far less than at least half of the students. I think teachers should be teaching the students, not being the ones being taught."

All students, male or female, are more likely to be engaged and motivated to use computer technology if they see computers as important tools for accomplishing their own goals. Future research should focus on equity issues investigating the effects and implications of computer use in the schools. As computers become part of our society, it is imperative that we consider equity issues and the voice of women in relation to computers, powerful tools with the potential to impact educational, economic, and social growth.

**Conclusion**

Compared to sixty years ago, new and developing technologies are no longer restricted to government, military, and higher education. Significant changes in computer technology
have multiplied from initial governmental and research purposes to unparalleled developments in education. Use of technology in the schools currently depends largely on implementation in classrooms primarily led by a majority of women as K-12 educators. Gender imbalance exists in the classroom as male students report higher levels of confidence, see computers as more useful, and attend more camps and classes. While female leadership from a pioneering individual such as Grace Murray Hopper or from two million women known as “Rosie the Riveters” demonstrated women’s technical competence, the post war job departure for women in these areas has not been equalized in the last 60 years.

The computer gender gap that once limited women in government and higher education, continues to limit women’s equal participation in 1990s computer-related occupations and college degrees. Computer-science degrees and computer-related career choices in the 1970s, 1980s, and 1990s continue to be male-dominated. The disparaging computer gender gap continues to distance females from the classroom to the workforce.

If history “repeats itself,” computer-related occupations and college courses will continue to be filled with a majority of males. Educators and policy makers may benefit from understanding the chronological development of hardware and software in the educational setting that began with uses in government, military, and higher education. With increased understanding, educators may be less likely to allow girls to compromise their abilities or interests in computers as tools for learning or productive work.

Therefore, perspectives and practices that maximize educational computing for females, as full participants, must be developed in student-centered, constructivist, computer-based learning environments of rigor and open-mindedness. Because developing familiarity and facility with computers is an important educational goal for all students, educators need to ensure equity in computer use, access, and outcomes. Thus, female accomplishment must be enhanced using computer technology for higher level thinking, investigation, problem solving, and reflection.
Teacher educators are key players in achieving gender equity with respect to computers. Because, “We Can’t Change What We Don’t Recognize,” (Reis, 1987) teacher educators face the challenge of preparing teachers, educational leaders, and potential educational researchers to perceive issues impacting equitable computer use in the classroom. We must rethink educational change and, on a deeper level, embody emotion and hope for change (Fullan & Hargreaves, 1997). We ought not to allow short-term results or superficial attempts to establish equity obscure benefits of the long-term, more thoughtful perspectives discussed in this paper.

In that female students have been traditionally underchallenged in their use of educational technology, we must help females reach their potential as learners and scholars of the twenty-first century. Literature on women’s studies suggests that girls define themselves through social interaction, connecting, and communicating with others more so than boys do (Gilligan, 1993). Educators may benefit from understanding computers as tools for social interaction, connection, and communication in order to help girls experience use of computers in meaningful ways. The U.S. Office of Educational Research and Improvement (1994) reports low teacher and parent expectations in mathematics, science, and technology. Expectations must be raised for females in and out of the classroom. Teachers and parents must facilitate opportunities for female computer exploration, leadership, and enrollment in advanced level studies.

Teacher-educators need an understanding of the history of developing technologies and the lack of female involvement. They must motivate and prepare new educators to skillfully integrate technology in the existing curriculum. Females in higher education must be role models and peer leaders. We need leadership of esteemed women to model use of computers in learner-centered, motivating environments engaging students in meaningful work. Educators must understand and implement effective uses of technology in a constructivist learning environment where the voice of female students and women educators is valued.
Such leadership and practices are imperative to promote a restructured, equitable climate for males and females to effectively use computers in the schools.

Technology won’t transform schools, but it can support educators in transforming their own role and helping students, especially females, to become active learners (Pearlman, 1989). Hawkridge (1983) suggests that schools adopt technology not just for social and vocational purposes, but to understand known advantages of computers (pedagogical rationale) to enhance learning, so they may be better prepared to reform teaching practices or to make desired changes in student learning (catalytic rationale).

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CHAPTER 3. PROBLEM SOLVING AND EDUCATIONAL COMPUTING: A REVIEW OF LITERATURE AMPLIFIED THROUGH THE VOICE OF ADOLESCENT STUDENTS

A paper to be submitted to the *Journal of Interactive Learning Research*

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**Abstract**

This paper reviews problem solving literature with particular attention to individual dispositions and learning environments with the potential to enhance problem solving activity. The literature review summarizes relevant research on problem solving and learning theory. Studies cited in this review range from early 1900s to current theory and application. Individual dispositions such as motivation, self-efficacy, self-regulation, strategy-use are discussed as they relate to problem solving. Learning environments that invite problem solving, such as constructivist, optimal, anchored, or situated learning environments are examined. Subsequent to understanding the theory of problem solving in appropriate environments, is the argument is that multimedia technology has the potential to influence students' problem solving facility. Amplification of problem solving instruction is highlighted through the voice of 8-11th graders, predominantly females, enrolled in a multimedia technology summer course specifically designed to develop student problem solving skills.

**Introduction**

The primary purpose of this research study is to survey the problem solving literature. Problem solving is a complex phenomenon that requires students to develop and integrate theoretical understandings of facts and processes with critical thinking skills in order to apply their knowledge to solve specific problems. Complex problem solving, however, has been traditionally an area in which females have not excelled (Meece & Eccles, 1993; Sutton, 1991; Shashaani, 1993). The possibility of intervention using computer technology as a tool for
learning holds promise for all students, particularly females, to develop skills and processes necessary to become better problem solvers.

This paper is divided into three sections. The first section provides a concise summary of problem solving research literature and instructional environments that best support the development of problem solving skills. The second section of the paper explores the potential for increasing students’ problem solving skills and achievement using multimedia technology. Because multimedia technology offers organization and retrieval processes for information handling and management in order to apply problem solving skills and increase retention of skills and knowledge, it appears that multimedia technology may be useful in developing complex problem solving skills (Jonassen, 1993; Jonassen & Grabowski, 1996).

The third part of the paper amplifies the review of literature on problem solving by introducing the voice of multiple perspectives of 20 gifted adolescent students (grades 8-11) enrolled in an elective 30-hour multimedia technology summer course. Offered through a residential pre-collegiate program gifted students, the course emphasized problem solving instruction using Eisenberg and Johnson’s “Big Six Approach” (1996). Students used Big Six skills to create and present a required electronic project, designed for a specified audience, using either Hyperstudio® or m-Power® authoring software. Importantly, this course was designed to incorporate problem solving instruction into the curriculum.

Views on problem solving from 5 males and 15 females were obtained voluntarily through student journaling and homework, semi-structured individual interviews, focus group interviews, and responses from the participants up to one year after the multimedia technology course was completed. This research examined the computer-use perceptions of females and males simultaneously enrolled in the multimedia course, with particular attention to the female experiences.

The goal of the study, then, is threefold. First, is to examine literature on problem solving; second to explore effective use of multimedia technology for developing problem
solving skills; and third to express the voice of adolescent students as they practiced problem solving skills. Important to the closing arguments, nonetheless, is enhancement of female student participation in using technology for problem solving.

**Problem Solving Literature Review**

Few educators deny the importance of problem solving. Requiring children to solve problems may be beneficial to students of any ability at any grade level. Societal imperatives place a high demand on thinking and reasoning skills of adult citizens who, by necessity, must be effective problem solvers. However, much of a student’s classroom experience involves pedagogical instruction, traditional academic practice, and routine skills. “Real world application of skills requires students to be able to use information in settings other than school, and to be able to make judgments about their actions” (Barrickman, 1997, p. 5). For this reason, the report by the National Commission on Excellence, *A Nation at Risk*, recommended that thinking skills and problem solving be taught in the schools (1983).

Problem solving, like higher-order thinking processes, tend to be non-algorithmic with a path of action not fully specified (Resnick, 1990). It is complex, often yielding multiple solutions influenced by nuanced judgments and interpretations. Problem solving frequently involves tolerating ambiguity, imposing meaning, and finding order in apparent disorder. Problem solving is a lifelong skill.

> “Students cannot possibly learn everything of value by the time they leave school, but we must instill in them the desire to keep questioning throughout their lives.” (Wiggins, 1989, p. 44).

The precise nature of problem solving is so complex that few educators seem to agree as to how problem solving may be specifically defined, and a wide range of definitions have been used to describe this important aspect of content disciplines. Problem solving, as evidenced in national standard strands (NCTM, 1991; NCSS, 1994), is perceived by most educators as being the essence of their field and a legitimate goal of education. On this point educators generally agree. All too often problem solving becomes a part of the hidden
curriculum, however, a topic we expect students to learn, but often fail to teach. In spite of our expectations about students’ problem solving, we neglect adequate provision of opportunities for students to become problem solvers. While educators increasingly recognize the value of problem solving in education, substantial efforts are hampered by a lack of knowledge of how to use problem solving in teaching. Therein lies a challenge for teachers to decide how to teach problem solving, where to teach it, and when to begin instruction relative to their content disciplines.

**Problem Solving Definitions**

In general, most educators broadly use *problem solving* to refer to creative problem solving. Problem solving is required when a person has a goal, but does not know how to accomplish it. Karl Duncker (1945) in his classic definition states:

> A problem arises when a living creature has a goal but does not know how this goal can be reached. Whenever one cannot go from the given situation to the desired situation simply by action, then there has to be recourse to thinking. Such thinking has the task of devising some action which may mediate between the existing and the desired situation (p.1).

In another definition Wertheimer (1959) refers to routine problem solving as *reproductive problem solving* when a problem solver already knows a method for solving a given problem such as determining the product of 67 times 4. According to the previous definition, however, this is not problem solving because the process is already in the individual’s memory.

Downing (1928) defines problem solving as essential thinking skills such as observation, analysis-synthesis, selective recall, hypothesis, verification, reasoning, and judgment. This definition, however, was designed for scientific reasoning rather than processes which would transfer to multiple content disciplines where other kinds of problems must be solved. As defined by Polya (1957) problem solving is a four-stage process that involves understanding the problem, devising a plan, carrying out the plan, and looking back.
He defined problem solving as finding a way out of difficulty, circumventing an obstacle, or reaching a previously unattainable goal.

Ausubel, Novak, and Hanesian (1978) define problem solving as a hypothesis-oriented discovery learning requiring the transformation and reintegration of existing knowledge to fit the demands of a means-end relationship. Their definition incorporates prior learning experiences or schemata in combination with components of a current problem to create a transformed or reintegrated knowledge base. Ausubel et al (1978) describe the highest expression of problem solving as the generation of new explanatory principles involving the creation of novel or original transformation of ideas. Agreeing with this explanation, Newell and Simon (1972) state that problem solving is defined as creative when the problem solved is of a new and different context.

Osborn & Parnes (in Davis, 1986) define problem solving as a series of five steps including fact-finding, problem-finding, idea-finding, solution-finding (idea evaluation), and acceptance finding (implementation) that lead to an action plan. Each step in the creative problem solving process, starts with a divergent phase followed by a convergent thinking phase. Learners must first understand (U) the problem to make it clear and to think about a good solution. They define (D) the problem broadly to get a wider picture of the problem and to open up multiple possibilities. They generate lots (L) of ideas, a core principle of brainstorming. Lastly, they evaluate (E) ideas carefully by listing criteria. Similarly, the Future Problem Solving program originated by Williams, Torrance, and Hornig (1978) includes three important stages of problem solving: (1) To state the problem and brainstorm solutions, (2) To formulate evaluation criteria, evaluate the ideas, and refine the best idea, (3) To “sell” and implement the best solution.

It is useful to distinguish not only between routine and creative problem solving, but to examine understanding of retention, transfer, rote and meaningful learning. Retention is the degree to which a student remembers the material that was presented, such as explaining the
process of photosynthesis. *Transfer* is the degree to which a student can apply what was presented in a new situation, such as setting up growth conditions of a plant while making inferences about how to solve problems, although the answers were not contained in the lesson. While learning is frequently assessed through tests of retention, the ultimate goal of many instructional activities is, indeed, transfer. *Rote learning*, then, is acquiring the prescribed knowledge, but lacking application, such as a medical student memorizing the 208 bones in the human body, yet being unable to identify those same bones in an orthopedic diagnostic evaluation. *Meaningful learning* is transferring skills to apply rote learning in a problem solving context, such as diagnostic casework to connect prior knowledge from medical school to a clinical situation. Both kinds of learning have purposes in education (Mayer, 1992).

Problem solving effectiveness is increased by metacognitive thinking. *Metacognition* (Flavell, 1979) is defined as “thinking about thinking.” Flavell states, “metacognitive knowledge is stored knowledge that has to do with people as cognitive creatures, as well as their diverse cognitive tasks, goals, actions, and experiences” (p. 906). Baker and Brown (1984) described awareness, monitoring, and deployment of compensatory strategies as *metacognitive skills*. Metacognitive awareness seems to be developmental, with increasing ability to judge the difficulty of problems as learners mature intellectually and chronologically. Both mental ability and metacognitive skills are responsible for individual differences in achievement of students who range from poor to average to excellent problem solvers.

In summary, there is consensus that problem solving involves a pursuit of a *goal*. The problem solver must recognize the problem exists and comprehend the nature of the problem well enough to define a goal. Secondly, there is agreement that problem solving is a *process* involving a sequence of steps or activities. Thirdly, problem solving involves *stimulating mental engagement*. Significant mental activities such as driving or calculating would only qualify as a problem, when in pursuit of cognitive goal which result in a determined solution in
an unfamiliar situation. Sherman (1988) emphasizes that "problem solving is a relatively sophisticated mental ability which is difficult to learn. We should expect sophisticated skills of any sort to be difficult to teach and time-consuming to learn; problem solving is not an exception" (p. 8). Additionally, problem solving is highly idiosyncratic. Effective problem solving is dependent upon one’s knowledge, prior experience, motivation, and dispositions.

Individual Dispositions Influencing Problem Solving

Because problem solving is highly idiosyncratic, disposition impacts effective problem solving. For example, self-efficacy influences choice of activities, effort expenditure, persistence, and personal judgments of one’s capabilities to organize and execute courses of action to attain designated types of educational performances (Bandura, 1981). Self-efficacy is distinguished from self-esteem by its specificity, in that self-efficacy measures students’ perceived self-confidence to do a certain task such as spelling or mathematics, rather than an overall sense of achievement in all academic areas. Self-efficacy is an important link between student ability and self-regulation. Self esteem constitutes part of one’s self concept, which is defined as a generic construct including, but not limited to, self-regard, perceived competence, and self-efficacy (Pajares, 1996; Schunk, 1991). Zimmerman’s (1986) research on self-regulation and academic learning emphasizes multidimensional criteria such as metacognitive, motivation, behavioral, and environmental processes effecting academic achievement.

Interestingly, this work shifts the focus from student ability level or environment at home or school as fixed entities to internal self-regulatory entities. Strategic qualities of self-regulated learners include personal abilities of appropriate time management, goal-setting, self-monitoring of progress, self-reaction, self-efficacy, and motivation (Zimmerman, 1994).

Students who believe they can, to a degree, control their destinies are more likely to be motivated to exert greater efforts in pursuit of their goals than those who think their achievements are ultimately out of their control. Similarly, Rotter (1966) called locus of control the perception of personal control which exists within a range of the ability to
completely control what happens in life to viewing life as a series of random events absolutely outside of one’s control. While neither view is realistic, the learner is more likely to take action if a relatively high level of perceived personal control is achieved. Mind set or attitude enables problem solving motivation and subsequent action.

Attribution Theory (Weiner, 1998) is a view of motivation that emphasizes the way individuals come to perceive and interpret their successes and failures. When a person succeeds or fails, they can explain their actions in various ways. They may attribute it to (1) **Effort:** success was due to hard work and failure was due to lack of effort, (2) **Ability:** success was due to inherently high ability and failure was due to low ability, (3) **Luck:** success reflects good luck and failure reflects bad luck, or (4) **Task factors:** success occurred because the task was easy and failure occurred because the task was unreasonably difficult.

The stability of attribution affects motivation. Students may think of their abilities, as well as the difficulty level of the task, as stable traits. They may think of their effort as unstable, that is, transient or controllable. Students with high achievement motivation tend to associate their success with ability and failure with lack of effort. Students with low achievement motivation tend to associate their success with luck and their failure to lack of ability. They may be unable to recognize successful problem solving strategies as the ability to solve problems well.

Dweck and Leggett’s theory (1988) distinguishes student perception of intelligence as either an “entity” or an “incremental” attribution. This critical determinant of achievement motivation is whether a person believes intelligence is fixed biologically, thus, not affected by environmental factors or whether it is “changeable or malleable.” Students who think their intelligence is fixed or is a stable trait, have an *entity theory* of their intelligence. Those who believe it is modifiable possess an *incremental theory* of intelligence. This research has profound implications for classroom performance. If students view their classrooms as those encouraging incremental improvements, they are more likely to use strategies to increase challenge and mastery. If students view their classrooms as those driven by the entity model,
they are more likely to limit problem solving strategies, blame difficulties on low-ability, or feel discouraged by their learning environment. They learn better by believing that “trying hard” impacts achievement and intelligence, thus, they are more likely to succeed where problem solving and mastery learning is valued in the classroom.

Motivational issues have drawn recent attention from scholars in the field of gifted and talented education. Purdue University researchers Dai, Moon and Feldhusen (1998) in their analyses of approximately 175 research studies on “Achievement Motivation and Gifted Students: A Social Cognitive Perspective,” reported that gifted and talented learners have higher academic self-concepts or perceived competence as compared to non-gifted students. They found gifted students have higher self-efficacy on mathematics and verbal tasks with more accurate predictions of their actual performance than non-gifted students. They reported high-ability students tend to hold incremental views of intelligence, thus believing that both ability and intelligence improve with effort. They reported gifted girls as more likely than gifted boys to attribute failure to lack of ability, and to believe that boys are smarter than they are. Girls were more likely to underestimate their mathematics, science, and technical skills. Some gifted girls, in the study, exhibited a maladaptive helpless motivational pattern rather than a mastery-oriented learning pattern. Gifted girls displayed lower self-efficacy and debilitating attributions under competitive learning conditions. Gifted girls preferred individualistic styles to both competitive or cooperative styles, while gifted boys preferred individualistic and competitive to cooperative styles of learning. In both groups, repetitive instruction, rote learning, and lack of intellectual challenge were causes for underachievement. Hollinger and Fleming (1984) and Kramer (1991) state that gender-role stereotypes in society, self-schema of femininity and masculinity negatively affected gifted girls’ achievement motivation. Not only do gender stereotypes and sex-typing of school subjects contribute to self-beliefs of ability, gender role socialization influences the value gifted girls attach to academic tasks. If girls
perceive mathematics, science, or technology-related competencies to be unimportant, then it is less likely that they will select those courses of study.

Rizza (1997) supported Dweck and Leggett's (1988) existing theory of attribution and goal orientation in her research with secondary gifted females in a public coed and private single-sex high schools. She found, contrary to literature on the benefits of cooperative learning, (Johnson, Johnson & Holubec, 1988; Slavin, 1995) female subjects preferred "solitary learning" activities, choosing to study individually as opposed to groups. Females in their study reported negative associations with competitive learning. Gifted girls, under competitive learning conditions, had "lowered self-efficacy and debilitating attributions."

Therefore, in order to sustain student interest in problem solving, educators must understand dispositions impacting student learning and create meaningful situations where students are in pursuit of their own goals. If students are to become good problem solvers, they must connect knowledge and strategies in meaningful ways. Students can learn to become good strategy users (Pressley, Borkowski & Schneider, 1987; Pressley, Woloshyn & Associates, 1995).

**Good Strategy Use in Problem Solving**

Good strategy users accomplish purposes beyond simple execution of a strategy, such as understanding a passage, by retaining learning for later recall. They use many strategies and techniques for either general or specific goals. Good performance, tied to effort and success, is more likely if competing behaviors, distractions, and emotions are limited. One aspect of specific strategy knowledge is critical for effective strategy use. That is, learners must know when their success is due to appropriate strategy use and when it is not. They need to know that some failures could have been avoided if they had used a better approach (Pressley, Borkowski & Schneider, 1987; Pressley, Woloshyn & Associates, 1995).

Teaching students to use strategies increases the likelihood that they will use strategies autonomously in a self-regulated manner. Strategies should be well-matched to authentic tasks
in school. New strategies should be thoroughly understood before adding new ones, as students monitor progress through self-checking. Even good students sometimes fail to monitor performance adequately or take corrective measures when problems are encountered. Making sure students know when and where to use strategies is an important aspect of strategy instruction. Metacognitive information plays a critical role in generalization and maintenance of strategies. Students are more likely to use strategies if they are aware that competent functioning results from appropriate use of strategies rather than from one's innate ability or just trying hard. These strategies, like problem solving skills, should not be taught as a separate topic, but throughout the curriculum in the context of content and skill development (Pressley, & Woloshyn & Associates, 1995). Solving problems in the context of curriculum is an integral part of individual learning (Sprio, Feltovich, Jacobsob & Coulson, 1992). Understanding how to solve problems occurs in a complex environment of classroom positive interrelationships and dependencies. Classroom environments in which students learn best, therefore, influence problem solving proficiency.

Learning Environments Influencing Problem Solving

The Cognition and Technology Group at Vanderbilt (CTGV, 1992) emphasizes problem solving in a macrocontext of situating learning. Learners, for example, explore video images to provide a context-rich setting of cues for the learner to develop problem solving skills. Their research found that when learning occurs in isolation as separate topics, the learning remains “inert,” or as stored information in one’s memory bank, and not recognized as relevant. Learning in context, then, facilitated the development of usable knowledge because the learner was immersed in “generative” tasks for an extended period of time. Their goal was to create subtasks that take on new meaning in a larger context, rather than being ends in and of themselves. New information was not seen as separate learning, but rather as information or tools for effective functioning in a larger context. The students were given an overall problem for functioning in the environment, such as “how to get home safely.” They generated
subproblems and strategies for achieving the larger task. A learner gauged understanding of the subtasks (such as calculating the needed fuel to get home) by the successful completion of the larger goal, not by a decontextualized standard. This approach lead to a significant increase in transfer of knowledge and a greater bank of useable knowledge.

**Anchored and Situated Learning Environments**

Children tend to access inappropriate problem schemata or give up when faced with unfamiliar or complex word problems. Haneghan, Barron, Young, Williams, Vye & Bransford (1992) researched problem schemata by suggesting important advantages of videodisc-anchored instruction over traditional text-based anchors. Anchoring problem solving in realistic contexts enhances learning and transfer of knowledge, rather than “inert” knowledge which is potentially applicable to a variety of contexts but only accessed in small set of circumstances. Favorable conditions for effectively anchored learning requires an instructional environment where both the teacher and the learner share a rich, real-world context to which many kinds of new information can be linked. Examples of conventional anchored instruction might include class field trips, laboratory experiments, apprenticeships, or on-the-job training. Videodisc medium or a “macrocontext” provides the next-best-thing, knowing many ancillary problem solving episodes aren’t realistically possible.

Students in the extended study directly formed a rich image or mental model of a problem situation. Such a meaningful, realistic context provided students with multiple perspectives (such as that of a scientist, historian, or mathematician) and moved to new contexts linking to the original anchor. Students had to develop pattern-recognizing skills to redefine problems and determine relevant information in order to solve the problem. The videodisc-anchored instruction had random-access ability, unlike a linear video tape, for teachers to facilitate instruction quickly and for learners to explore the same disc from multiple perspectives. Preceded by promising research findings using short film segments from, Indiana Jones and the Raiders of the Lost Ark®, junior high school and college-aged students
learned to apply specific scientific weight-density concepts of gold and sand in order to assist Indiana Jones in the deceptively simple rescue of the golden idol on weight-sensitive pedestal. Students in the experimental group, associating the use of 13 short passages of scientific concepts with the movie, outperformed the control group (reading the same passages in unrelated contexts) in applying the concepts to the situation as well as in tests of information recall. In following studies of specifically designed series of video anchors called *The Adventures of Jasper Woodbury*, a real world context for mathematical problem solving is provided in a narrative format to present information. Fictitious character Jasper Woodbury, takes a river trip to see an old cabin cruiser he considers purchasing. After a test-run Jasper and Sal, the owner of the cruiser, must determine if he can get the old boat home to his dock before sunset, as the lights are inoperative. Two major problems include figuring out if there is enough fuel to return and enough time to arrive before sunset. Students motivated by the story, must engage in much complex thinking, and are active generators of knowledge, rather than passive recipients. They must identify problems, formulate solutions, and recognize a number of relevant number facts from the videodisc which helps them solve the problems they create. In response to the Jasper series, teachers noticed that students worked in groups for long periods of time in sustained effort to solve problems. Students reported that they thought about this problem at home and tried harder on this than anything else done in school. They said this lesson taught them “to listen,” to “use common sense,” and to use “short term memory” (Haneghan, Barron, Young, Williams, Vye & Bransford, 1992, p. 29).

Similarly, *situated cognition* (Brown, Collins & Duguid, 1989) supports a culture of learning. The “learning culture and academic tools such as algorithms, routines, decontextualized definitions work together to determine the way practitioners see the world” (p. 33). The authors have speculated the gap between “know how” and “know what” may well be a product of our educational system. In a didactic “know what” approach to education, learners are separated from knowing and doing, and therefore treat knowledge as self-sufficient
and independent of the situation in which it is learned and used. "Know what" schools tend to present activities and concepts in a decontextualized, abstract, formal approach which is disconnected from application of knowledge. By ignoring the nature of learning and cognition, educators defeat their own goal of providing useful knowledge. Instead, a "know how" approach such as cognitive apprenticeship imbed learning in activity which makes deliberate use of social and physical settings which enhance the culture of learning. In another example, Lave (1997) in her research on the culture of acquisition and the practice of understanding supports cognitive apprenticeships as an approach assuming that processes of learning and understanding are socially and culturally constituted. Apprenticeship learning is likely to be based on assumptions that knowing, thinking, and understanding are generated within the culture of specific practice.

Authentic activity, therefore, in anchored or situated learning is important for learners because they gain access to meaningful and purposeful use of academic tools. In an analysis of situated learning criteria, Wblfson and Willinsky (1998) determined that learning could be said to occur if the learning situation emphasized the four parameters of situated contexts, authentic contexts, collaborative contexts, and reflective contexts. The constructivist environment creates contexts in which students become reflective learners.

**Constructivist Learning Environments**

Reigeluth (1992) states that constructivism is a valuable perspective that has much to contribute to our understanding of how to facilitate authentic learning. Reigeluth argues that constructivism is not the only valuable perspective in education, however. Constructivist learning may not be equally useful in all learning situations, in that sometimes we are striving for a correct answer or to acquire specific understandings and skills. Pragmatic educators cannot afford to narrowly operate in an single ideology or with one dogmatic style.

We must be more concerned with decisions on what to teach than how to teach it. Decisions on what to teach are made primarily on the basis of pragmatism and philosophy. Decisions on how to teach are made on the basis of what works best for different kinds of learning, learners, and situations. (Reigeluth, 1992, p. 150).
Proponents of constructivist learning theory concur that when prior knowledge connects to newly acquired skills and current experiences, meaningful learning exists. An engaging environment as opposed to a contrived one, is more likely to link previous experiences, promote problem solving skills, and encourage self-efficacy.

Brooks and Brooks (1993) define constructivism as a "real world" that we experience. Meaning is integrated in life experiences in which these ideas are embedded. Experience is critical to the individual's ability and understanding of ideas. Therefore, experience must be examined in order to understand that learning occurs. Most of us realize experiences and concepts in the school setting differ from those in the real world. These differences contribute to underlying reasons explaining failure of transfer of school learning to real world learning. Most learning in school is contextualized within the context of school rather than supporting the individual in making sense of the real environment as it is encountered.

Bednar, Cunningham, Duffy, and Perry (1992) describe constructivist learning by stating that instructional systems theory must deliberately apply constructivism to the design and development of instructional materials so that specific outcomes cannot be disconnected from content. Learning should focus on the process of knowledge construction to complete authentic problems resulting from addressing real-world issues. Learning processes should be modeled for students with "unscripted teacher responses" in order for learners to construct their own multiple perspectives and views.

The constructivist goal is not to expect individuals to know certain things, but to assist learners in constructing plausible interpretations of ideas in solving problems (Duffy & Jonassen, 1992; Duffy, Lowyck, Jonassen, 1993). Plausible interpretations include developing alternative goals and perspectives supporting interpretations, not looking for the one correct answer. This is not simply a higher order thinking skill independent of the problem to which it is applied.
Constructivism implies that the learner is an active processor of information and, more importantly, elaborates on and interprets new information in connection with prior knowledge. The learner comes to the classroom with innate goals and curiosities, actively seeking and constructing knowledge. A constructivist approach supports an environment where teachers and student learn together and share knowledge (Nicaise & Barnes, 1996).

The constructivist approach in the classroom invites the teacher to facilitate active inquiry, direct instruction as needed, encourage divergence from the lesson plan, and to be reflective during the instructional process. The teachers' role is to organize the environment, give clear directions, raise stimulating issues and ideas, provide ample time for student responses, teach and model negotiating strategies, use student ideas in posing new questions, reflect regularly on curriculum and teaching strategies, facilitate information gathering techniques, and admit the possibility of multiple approaches. The role of the student, then, is to listen attentively, discuss and synthesize concepts and ideas, propose alternative solutions to problems with peers, work both cooperatively and independently, produce novel products, and present finished products (Cadiero-Kaplan, 1999). Therefore, constructivist teaching more productively leads to the development of student-developed strategies for managing complex problems. Active learning is not just a phenomenon of thinking (Perkins & Salomon, 1989). The integrity of the whole task must be maintained with a focus on a "phenomenaria" environment rather than an "information bank" environment. A constructivist learning environment demands more of the learner (Perkins, 1992).

In summary, a process-oriented, constructivist learning environment may provide greater opportunities to develop effective problem solving attitudes and competencies of students. With less emphasis on facts and more emphasis on higher-order thinking and problem solving skills (Panel on Educational Technology, 1997), more attention is given to complex learning over learning the content. Such environments sustain concentration and collaboration of the learner in the pursuit of problem solving goals.
Optimal Learning Environments

Engaging, optimal learning environments are described in the following research studies of Csikszentmihalyi (1990), Vygotsky (1933), Dewey (1933), and Bereiter and Scardamalia (1993). Csikszentmihalyi’s (1990) research concludes that meaningful learning is a joyful experience. Complex, intellectually invigorating learning situations sustain student efforts. Mihaly Csikszentmihalyi (1990), distinguishes joy from pleasure by describing the latter as discriminate sensations from experiences such as gourmet food, where enjoyment, requires investing in goals that are new and challenging. Csikszentmihalyi summarizes optimal learning from over 12 years of extensive questionnaires and interviews with individuals from the United States, Thailand, Korea, Japan, Australia, various European cultures, and a Navajo reservation. Optimal learning is experienced by a cardiology surgeon, an inner-city teen on a basketball court, or a fifth grade child figuring out a mathematics problem. Regardless of culture, class, age, or gender, individuals described optimal learning in much the same way. While their tasks differed widely, they described their experiences similarly. Components of Csikszentmihalyi’s optimal learning experiences include:

1. The experience usually occurred when confronting tasks one has a chance of completing.
2. Individuals were able to concentrate on what they are doing.
3. The concentration was usually possible because the task had clear goals.
4. Immediate feedback was available through internalized criteria, trial and error, or explicit response.
5. Individuals acted with a deep but effortless involvement, that removed awareness of worries and frustrations of everyday life.
6. Enjoyable experiences allowed people to exercise a sense of control over their actions.
7. Concern for the self disappeared, yet paradoxically, the sense of self emerged stronger after the optimal learning experience was over.
8. The sense of time was altered so that hours passed by in minutes, and minutes stretched out to seem like hours.

Optimal learning experiences are more likely to occur in learning environments that account for the social needs of learners. Alschuler, Tabor, and McIntyre, (1970) applied Maslow's classic Hierarchical Needs Theory (physiological, safety, belonging and love, self-esteem, knowing and understanding, aesthetic, self-actualization) to a specific needs theory relevant to classroom teaching and learning. Known as "Needs Disposition Theory," individuals are motivated to take action and invest energy through either achievement, affiliation, or influence motives. Through achievement motives, students strive for competence. They pursue excellence intrinsically. Through affiliation motives, students value the social interaction, support, and friendships of peer relationships. The motivation of influence becomes important when students strive for more control over their learning tasks, their learning environment, and in their lives. One's feelings about competence, affiliation, and influence at school is related to socialization.

Socially-Constructed Learning Environments

Socialization increases the potential of learners to engage in new and puzzling situations in order to resolve discrepancies induced by problem-based experiences, according to Russian psychologist, Lev Vygotsky (1933) who emphasized the social aspects of learning. Learners better construct new ideas and develop intellectually when interacting with one another. He states that learners have two levels of development—the level of actual development to learn particular matter individually and the level of potential development at which an individual can function or achieve with other learners such as a teacher, mentor, parent. The zone of proximal development (ZPD) is defined as a zone between the learner's actual level of development and the level of potential development. Problem solving proficiency, then, is enhanced with appropriate interaction and challenges with peers, teachers, and others to advance the zone of proximal development of the learner.
Vygotsky suggests that social experiences shape the way learners think and interpret the world, and that individual cognition occurs in a social setting. Group activity, therefore, is vital to linking the learner with higher forms of mental activity through interaction with more knowledgeable peers and adults. Vygotsky's theory is based on a non-linear view of education, whereby each learner's intellectual capacity and knowledge is constructed by internalizing concepts through active participation in the instructional process not through passive instruction. Importantly, the teacher is a facilitator of experiential learning, in a bottom-up approach, orchestrating (not imposing) what and how students learn in the classroom setting. The teacher activates the learner's zone of proximal development (ZPD) through modeling and scaffolding techniques (Bruner, 1975; Beed, Hawkins, Roller, 1991) at a level just above the student's current skill and knowledge level which motivates the pursuit of excellence. Problem solving skills of a less competent student are built in collaboration with a more competent learner. Social interactions elicit various perspectives about a problem. Learners compare ideas, clarify thinking, and address misunderstandings through collective work without waiting for a teacher to intercede. Together, students develop better skills to communicate, explore, and conceptualize problems (Peters, 1996; Harvey, 1997).

Problem-based instructional theory finds its intellectual roots in the classic research of American pragmatist, John Dewey. In his view of democratic education, schools mirror the larger society. Classrooms were laboratories for real-life inquiry and problem solving. Dewey celebrated the importance of the pupil understanding the "process" approach. Like Vygotsky, Dewey's approach encouraged teachers to help students to engage in problem-oriented projects and to help them inquire into important social and intellectual problems. Dewey argued that schools should be purposeful rather than abstract and that purposeful learning could be best accomplished by having children pursuing projects of their own interest and choosing in small groups. Schools were important to his vision of American society. Dewey considered the
school as social institution, a learning laboratory, in which to align curriculum to real-life occupational and democratic experiences of the surrounding society.

Curriculum was constructed cooperatively by the students and their teacher. Together with a commitment to scientific methodology, schools functioned as vehicles for the improvement of democratic society. Dewey did not assume that a child-centered curriculum disposed of traditional curriculum content, rather that subject matter might be reorganized through problem solving. This vision of problem-centered learning, fueled by students' intrinsic desire to explore personally meaningful situations, linked contemporary problem-based learning with Dewey's classic philosophical and pedagogical style. Both Vygotsky and Dewey influenced pragmatism and problem solving in educational environments, a movement still regarded today in the development of learning.

A more recent example of a socially constructed learning environment is known as the knowledge-building community (Bereiter and Scardamalia, 1993). The authors define a progressive problem solving environment as one that builds expertise. A classroom should function collectively as a knowledge-building community advancing knowledge to formulate higher goals and to deepen understanding. Classrooms should not simply be a collection of people who individually pursue knowledge or diverse interests. Rather, they should function collaboratively as a community of learners to share knowledge, support each other as "expertlike learners," thus building expertise. Even academic environments of most university departments are "nonexpert" environments.

Most university departments are not knowledge building communities, even though most faculty members may belong to research centers, which are. Departments are usually held together by their teaching functions....Schools, clearly, are more like [university] departments. What one student learns does not matter much to the others even though everyone benefits from to a class full of good learners. (Bereiter & Scardamalia, 1998, p. 202)

Bereiter & Scardamalia depict most school environments as "Nonexpert Societies" that impede learning. Instruction favors schemas for rapid presentation and retrieval of knowledge,
frequent shifts in topics, and minimal demand for reflection, interpretation, and reconstruction of information. Serious school defects include: (1) recognizing only formal knowledge and skills, not the informal kind that students bring with them and need to function expertly in real life, (2) translating knowledge objectives into tasks and activities without sharing with students the very objectives which give rise to the learning activities and tasks, and (3) providing progressive problem solving expertise for the teacher, and not for the students or being unable to apprentice students in problem solving learning situations. School curriculum guides have become lists of facts and principles to be taught, skills and concepts to be covered, and a series of activities, games, experiments, projects to do. Learning bears more relevance to routine procedures, than established goals or problem solving strategies. In an environment such as this, students are unlikely to adopt for themselves expertlike approaches to learning or to sustain their efforts at the edge of intellectual competency to real life solve problems of increasing complexity.

In summary, greater opportunity for complex problem solving exists in school learning environments that support the development of knowledge-building and meaningful social interaction among learners. Engaging, constructivist learning environments that sustain concentration and effort of the learners hold greater promise to build student problem solving proficiency.

**Multimedia Technology Inviting Problem Solving**

Critical concerns surrounding peak growth of educational technology in instructional settings have moved beyond technological naiveté to effective school practice. America’s schools are under increasing pressure to justify the estimated $5 billion investment in educational technology (Archer, 1998). Computers are not “magical devices or silver bullets to solve the problems of schools” (Dede, 1997, p. 13). Buying more computers is not the answer. According to McKinsey and Company (1995), supplying one media-capable Internet-connected computer to every two or three students would cost approximately $94 billion for
initial investment and $28 billion per year for ongoing costs. Such expenditures would drain discretionary funding sources in U.S. schools. Rather than large-scale, impractical systematic integration, localized applications seem more reasonable. Decisions to expand hardware and software access must reflect effective use of funds and resources.

Limited budgets for the purchase of technology require that expenditures should ideally assist learners in knowledge-building, problem solving activity in learning environments supporting how children learn best. Technology can make a difference, but those benefits depend on how the technology is used. Therefore, judicious use of technologies must involve teacher and student ownership to build skills in an environment able to influence thinking, learning, and problem solving.

It seems that multimedia technology harnesses considerable potential to build problem solving skills in a learning environment where the "path of action is not fully specified" (Resnick, 1990). Use of multimedia invites an opportunity for problem solving where students are in pursuit of a goal, use a sequence of steps, and sustain stimulating mental engagement (Beisser, 1999, p. 51). Multimedia systems offer organization and retrieval processes for information handling and management. Learners can coordinate the information abundance with procedural knowledge by conducting systematic searches of available resources and to make meaning of relevant information content and expertise. Additionally, sifting through irrelevant data, students learn to select pertinent information and to discard the rest. Use of multimedia technologies act as a conduit for accessing and organizing, presenting and evaluating information. With teacher-mediated instruction and guidance, multimedia technologies open wide the door of developing the problem solving potential of all learners.

Multimedia interactivity engages the learner in a rich environment using all the senses, providing an environment for control and manipulation of information. Multimedia requires use of multiple components such as cassette and recorded sound, video, digital cameras, scanned text and graphics, and Internet sources. These are transported to a selected computer
software program in conjunction with a central theme or concept uniting the information in
non-lineal format (Jonassen, 1996, p. 187). With options and buttons to access, navigate, and
manipulate data, learners can interact with information in order to solve problems based on
inference assembled from their prior knowledge. “The computer can assess the learner's
inference sampling and decide whether the learner has collected an adequate sample and if the
conclusion reached is justified. Such systems allow learners to develop problem solving
skills” (Multimedia, Annual Editions, 1994, p. 138).

Jonassen's (1996, p. 186) mindmap (see Figure 1) depicts multimedia as the
integration of more than one medium into a form of communication within the classroom
context. Student decision-making is at the center of the process. Multimedia involves
multimodality which stimulates more than one sense at a time, attracts and holds attention of the
learner, and has the potential to build skills in a problem solving framework when related to
classroom curriculum content and skills. Hypermedia is composed of links and text connected
in a non-linear fashion. “Many educators believe this is essential when working with today’s
generation” (Jonassen, 1996, p. 187). Hyperauthoring allows students to connect knowledge
and research through the use of process skills to manage an electronic product requiring
organization, planning, reflection, and presentation.

According to Guzdial and Kehoe (1998) becoming a skilled practitioner means learning
both conceptual and process knowledge. They suggest that use of hypermedia provides
components of an apprenticeship learning model, in which both process and conceptual
knowledge is integrated. An apprenticeship model “results in students gaining the conceptual
and process knowledge of a skilled practitioner, which includes outcomes such as problem-
solving skills and transfer of knowledge that school reform efforts seek to develop” (p. 291).

Multimedia technologies challenge educators to build applications that fit curriculum
content areas and learning styles of their students. The attention-getting capability of
multimedia is undeniable. It is no wonder multimedia technologies are pervading the
Figure 1. Multimedia and Hypermedia Mindtools
classroom. Although many programs excite the imagination with dazzling features and flashy options, educators must harness the power of multimedia technologies to go beyond knowledge and comprehension and build computer literacy skills which invite higher order thinking in relation to appropriate curriculum content.

Using multimedia technology for information handling and problem solving within the context of classroom curriculum holds promise for developing computer skills according to Eisenberg and Johnson's "Big Six Approach" (1996). The "Big Six" is an information literacy curriculum of information problem solving process to build skills and strategies for efficiently and effectively meeting information needs in academic or personal decision-making tasks. When taught within curriculum content areas, students purposefully implement new technologies, particularly multimedia, for problem solving.

The six skills include (1) **Task Definition**-to define the problem and identify information needed to complete the task or solve the problem. For example, students use e-mail, on-line discussion groups, desktop conferencing, idea generating software to facilitate task definition or define a research question. (2) **Information Seeking Strategies**-to brainstorm all possible sources to select important sources. Students might use databases, CD-ROMS, commercial or on-line resources, listservs, newsgroups, computer organized charts and timelines to organize complex tasks. (3) **Location and Access**-to locate information from a variety of sources and access specific information found within individual resources. For instance, students might discover networked resources, electronic periodicals, on-line catalogs, multimedia stations, biographical information, scanners, digital cameras, Boolean searches, self-conducted electronic surveys, or contact expert sources. (4) **Use of Information**-to read, view, or listen to data and to extract relevant information. Students might view, download, decompress, cut and paste information, take notes, use electronic spreadsheets, statistical software, filter out unnecessary information then record and cite sources properly. (5) **Synthesis**-to organize information from multiple sources and present the information. Students may classify
information, use word processing and desktop publishing, create multimedia or hypermedia presentations using text, graphics, sound, video, WWW, generate charts, graphs, art to share both the process and the product. (6) Evaluation—to judge the process (efficiency) and judge the product (effectiveness). As an example, students may evaluate the electronic presentations for content and format, use spell check and grammar checks tools, properly cite resources and thoughtfully reflect on the appropriate use of electronic resources and tools throughout the problem solving context.

Universal support of technology as a means to improve teaching and learning does not exist. While technology can make learning fun or easier, support is inconclusive that technology causes gains in student achievement (Baines, 1997, p. 498). In what many consider to be the most controversial article in the area of media research, Clark summarized nearly 70 years of research by stating, the best evidence is that media are “mere vehicles” that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in nutrition. “Only the content of the vehicle can influence achievement” (Clark, 1983, p. 445). Clark suggested that research on educational media should not seek to discover which medium is best, but should focus on other, more appropriate independent variables that effect learning. Specifically, Clark concluded that educational media research should examine the effectiveness of various instructional approaches to enhance teaching and learning.

In support of technology for instruction, Bereiter & Scardamalia’s (1993) research on Computer Supported Intentional Learning Environments (CSILE), suggests computer-based technology can link school culture to the real-world. They maintain that computer technology sustains the kind of information flow necessary to build knowledge building communities within the school. In a CSILE environment students can use networked computers to create a community database of information and connections. Embedded in curriculum content, learners create text, graphics, projects, to comment on or critique one another’s work.
Computers can provide each student with access to what other students or real-world experts are doing. Students can index new information through electronic knowledge bases, simulations, and linkages to expertise. The community database serves as an objectification of the group's advancing knowledge, much like a scholarly journal. Publication, or sharing knowledge as refereed journal publishing, is encouraged. Juried contributions must meet the requirements of other students with final clearance by the teacher. At the end of the year, the students decide what remains in the database for students coming after them, similar to the real-world of work where each generation does not have to rediscover basic knowledge, but can progress beyond the findings of others.

Dependent on structure and teacher guidance, CSILE moves learners toward knowledge building, self-maintaining classroom communities. Rather than merely reporting information, students collaboratively advance the knowledge of their task group and their class. Students seem to be "functioning beyond their years, tackling problems and constructing knowledge at levels that one simply does not find in ordinary schools, regardless of the calibre [sic] of students they enroll." (Bereiter & Scardamalia, 1993, p. 215).

Use of technology enabling schools to accomplish this kind of learning, is going to be largely wasted unless schools restructure into learning communities that actually build knowledge from their resources (Bereiter & Scardamalia, 1993). Easy access to information technology through compact disks, videodisks, networked information and expertise must be guided by deeper educational issues if educational computing is to enhance meaningful instruction.

In summary, multimedia technology has the potential to enhance problem solving in that learners are in pursuit of a goal. Secondly, the problem solver interacts with various facets of multimedia technology in a process-based sequence of steps or activities. Thirdly, problem solving using multimedia involves stimulating mental engagement best developed in constructivist environment. Such an optimal learning environment invites problem solving
within the context of curriculum content and skills where socially-constructed experiences reflect effective instruction and understanding of individual student dispositions.

**Voices of Students Using Technology for Problem Solving**

Incorporating literature on problem solving, dispositions for problem solving, and effective environments that nurture problem solving, a 30-hour Multimedia Mania summer course for 8-11th graders was purposefully designed. Twenty gifted students from Midwest high schools of various sizes enrolled in an tuition-supported course to develop skills in multimedia technology. BigSix Problem Solving Skills (Eisenberg & Johnson, 1996) instruction was imbedded the context of using multimedia technology to author an individual electronic project by the end of the class. Students learned and applied Hyperstudio® and m-Power® software for projects based on a topic of their choice or a self-selected interest area. Students using multimedia technology were in pursuit of a goal, interacted in a sequence of steps, and engaged in stimulating project instruction and design. Problem solving was not part of the “hidden” curriculum of what students were expected to learn.

When interviewed individually and in focus groups about using computer technology as a tool for problem solving during the multimedia class, all students affirmed that computers, in general, helped them better organize their thoughts and ideas. One student said, “I’d have to say our brains are the biggest problem solving tool, but the computers help us organize our thoughts.” Another student considered computers as a “boundless resource” helping with different ways to complete schoolwork, homework tasks, or to communicate. Others valued the computer as a “tool for problem solving because it has so many applications.”

“Computers help me with problem solving when I try to solve problems on them, taking different routes to what I want it to do.”

“I think that it is a tool for problem solving because I think rationally when I write things down. The easiest way for me to organize my thoughts is to type things up.”

“When writing essays or stories, I will use my computer dictionary to find synonyms to make my writing more interesting. Sometimes, my ideas aren’t quite organized
for essays and journalism assignments. In this situation I will type up all of my ideas, then use ‘cut and paste’ to sequence them in the order I want.”

Some students, however, digressed from the importance of multimedia and problem solving to computer games as problem solving.

“I really don’t use the computer as my problem solving tool...that is, unless, you count Solitaire® as problem solving. I guess doing homework can be a form of problem solving. In that case, I use it to type documents. Other than Solitaire® and doing stories, Riven® is a pretty damn difficult game that requires problem solving.”

Other students reflected on problem solving caused by their computers.

“The computer is a tool for problem solving because when something doesn’t work you go through the problem solving steps to try to fix it. For example, when my printer didn’t work, I tried to fix it myself by finding out what the problem was. When I was unable to locate the problem, I called the company and am now able to use the steps they told me to find the problem and fix it. By calling the company I used problem solving skills I would not have needed, though, if I didn’t have a computer!!”

Some thought error messages from using computers required them to use problem solving in operating the hardware.

“Computers help with problem solving because you have to be able to figure out how to fix the problems and make things work right. Macs are GREAT for teaching problem solving because they give you errors every two minutes and all it says is "error type 2", and if that doesn’t teach problem solving, what does?”

Although instructed in the using the BigSix Problem Solving Approach (Eisenberg and Johnson, 1996) during the multimedia course, students had trouble recalling the problem solving sequence in follow-up interviews, despite learning and applying the steps daily during instruction while taking the computer course.

“At the moment, I can’t even recall the steps of problem solving. That would require me to run upstairs, run around from room to room, dig through a bunch of papers until I found the handout of the steps of problem solving, run downstairs, realize I forgot the paper, run back upstairs, grab it, run back downstairs, pet the dogs, and type them up like the weasel I am. How’s that for steps? So to answer your question, no, I don’t recall the problem solving steps.”

In addition, many of the students resisted the instructional process of learning problem solving strategies. They preferred to plan and create without reflecting on strategies or steps.
"I guess it was just we hadn't ever done it [problem solving] before and that it [problem solving instruction] was too much like school. And it was also too much work."

"It was so freakin' boring! I believe this generation is more of a hands-on generation. One reason I came to the computer [class] was to get away from the normal classroom setting and have 99.9 percent hands on. Instead, I got to re-re-re-re-re-re learn the steps of problem solving."

"I did not like it because it disrupted the smooth flow of my thoughts. When I am problem solving, my thoughts come so swiftly that the process of analyzing my thoughts and placing them into neat little categories disrupts my flow of ideas and makes it harder for me to problem-solve."

"It was a drag for me because I don't like to have to slow down my thought process to answer stupid questions, it makes it harder to keep your train of thought. You've got talented and gifted students, you don't need to teach them how to think, we've already figured out how to accomplish things without having to stop and think about the rules of the Big Six."

Not all students agreed, however, that problem solving instruction was irrelevant. Some did not resist instruction and found value in learning problem solving skills.

"Problem solving" really wasn't bothersome to me, but I think it was hard and boring for some because they don't use it often. I think if we were used it on a regular basis, it would help us a lot."

"I like learning about the problem solving process. It was helpful in locating sources and processing information. It really made me think about my audience. I chose to present my project on a program I had never heard of, m-POWER. This is similar to Hyperstudio. I learned how to connect cards using 'hot buttons,' how to integrate short movie clips into my program from a video, download a graphic (which I turned into a background), and how to connect a slide on my m-POWER project to a site on the Internet. I learned so much about identifying the steps in problem solving. It was hard to understand at first, but what a help it was, once I got the hang of it! I learned to scan in pictures and use a digital camera.

This student felt she could better use the computer after the multimedia course, and could "catch on to other programs more efficiently and quickly" because of her problem solving experience.

Although students held various opinions about learning problem solving skills during the multimedia class, they clearly used those skills in completing and presenting complex independent electronic multimedia projects at the end of the 30-hour course. The course required students to infuse previous knowledge to complete authentic projects addressing real-
world issues of interest to them. An example of a project topic included the history of Boys Scouts of America developed as a program to encourage young Scouts of the importance of goal-setting in order to reach Eagle Scout status. Another example exposed the diminishing population of the North American Wolves and how unmitigated fear still affects the safety of the wolf. One other topic included the history and magnificence of Mt. Vernon, Virginia as more than a tourist site of George Washington's home. Learners conceptualized knowledge by using multimedia to construct "plausible interpretations of ideas" using a problem solving process. Students developed alternative goals and perspectives supporting interpretations of their topics in the final electronic projects presented at the end of the course.

Learning occurred in a socially-constructed environment. Each student had a media-enhanced computer, but they did not work alone. There was seldom a quiet moment, as students shared techniques on downloading video clips, sounds, and graphic images to augment their projects. They worked tirelessly, even through the scheduled breaks for lunch and rest. They commented that time "flew by like minutes" (Csikszentmihalyi, 1990) as they concentrated. They worked in knowledge-building communities (Bereiter & Scardamalia, 1993) sharing information or websites to help someone else. They hovered over each other, leaned from one computer monitor to the next peering at others’ projects to help one another build skills using software features or multimedia lab equipment. Instructors facilitated learning in a learner-centered (McCombs & Whistler, 1997) environment building on prior knowledge to make meaning through "interactive, not passive isolated learning" using multimedia technology to solve problems (Vygotsky, 1933).

**General Conclusions**

While few educators deny the importance of problem solving, a wide range of definitions are used to describe problem solving. Problem solving is highly idiosyncratic requiring higher order thinking processes in a non-algorithmic path of action not fully specified (Resnick, 1990). Problem solving is an engaging, goal-seeking, multi-step process influenced
by learning environments that invite the connection of curriculum and skills. Problem solving proficiency is enhanced where socially-constructed experiences reflect effective instruction and understanding of individual student dispositions.

Multimedia technology, then, is an electronic tool with the capability to build problem solving skills because of the existing parallels between human memory and the architecture of hypermedia systems. Indeed, the computer has provided a strong metaphor for associative memory, non-linear connections, linking ideas, and causing related information to be indexed and displayed. The learner is in control of the process and can make unique use of prior knowledge in the process. By progressing through the architecture of a hypermedia document selecting links between ideas, causing the related information to be displayed, readers have unprecedented control over the scope and sequence of what is read, as long as the author provides enough links, and as long as the links make sense to the reader (Nelson, 1994).

Multimedia technology may enhance problem solving skill development as learners interact with the technology to organize, modify, manage, and communicate ideas in the learning process. Systematic and thoughtful use of multimedia-capable technologies (McClintock, 1992) focus on individual self-regulatory processes. Using multimedia for learning invites qualities of self-regulation of time management, goal-setting, self-monitoring of progress, self-reaction, self-efficacy, and motivation (Zimmerman, 1994). Students using multimedia have a choice of technology-based activities, effort expenditure, persistence, and judgments to organize and execute courses of action.

Student-centered learning environments can promote effective use of multimedia technologies. Multimedia technology may serve as an effective tool for learning problem solving skills to build on prior knowledge to make meaning through interactive, not passive isolated learning (Vygotsky, 1933) to share problem solving together. Use of multimedia technology involves multimodality which may stimulate more than one sense at a time, attracting and holding attention of the learner, and build skills in a problem solving framework.
Building skills in problem solving schemata and sharing collaboratively in the advancement of knowledge and techniques using multimedia technologies, has the potential to create knowledge-building communities (Bereiter and Scardamalia, 1993). As a community of learners corroborate in sharing knowledge and process, use of multimedia technology has the potential to increase reasoning ability. Multimedia technology, used with self governing tasks to connect learners to relevant content and issues, may be a tool to increase problem solving proficiency in order to facilitate reasoning skills and build expertise. Great possibility exists if educators couple theory and practice in intentional, engaging learning environments to build problem solving expertise.

Acknowledgements

I gratefully acknowledge Dr. Thomas Andre, ISU, for his guidance in preparing this paper.

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CHAPTER 4. GIFTED ADOLESCENT FEMALES' PERSPECTIVES USING COMPUTER TECHNOLOGY

A paper to be submitted to Gifted Child Quarterly

Sally R. Beisser

Abstract

During an elective multimedia technology summer course designed for 20 gifted adolescent learners, students learned and applied problem solving skills in the development of a multimedia project in a self-determined area of interest. The study examined differences in perceptions of females and males using computer technology in and out of the classroom, with particular attention to and interpretation of the female experience. The paper emphasizes female student perspectives of computer use, including students' views of peers, parents, and teachers using technology. Moreover, this paper describes an "engendered" (Gilligan, 1993; Lindsey, 1997; Bloom, 1998) adolescent computer culture limiting full participation of females in computer-related experiences. The computer gender gap, continuing to distance females in the classroom from full participation using technology, is discussed in the final section.

Introduction

Gender disparity exists in educational environments despite conscientious attempts to equalize opportunities and outcomes. Sex differences persist in attainment of careers in the related fields of mathematics, science, and technology (Meece & Eccles, 1993; Sutton, 1991; Shashaani, 1993). Much effort has been made to change the patterns of attitudes and behaviors that lead to unequal outcomes (Kahle & Meece, 1994; Fennema, 1990).

Substantial gains have been realized in policy inviting equal opportunity for females and males. In 1972 the U.S. Department of Education passed Title IX, a legal effort designed to
reform gender inequality in schools. This amendment stated that "no person in the United States shall, on the basis of sex be excluded from participation in, or denied the benefits of, or be subjected to discrimination under any program or activity receiving federal aid." This amendment influenced both education and legislation to ensure equality for girls and boys in schools. In 1995 United Nations Children's Fund (UNICEF) launched a worldwide campaign to promote educational achievements for all girls. Like Title IX, this campaign has yet to significantly influence academic status and opportunities for females. Both federal initiatives demonstrate awareness of gender disparity in the current state of education, yet do not assure gender equality. Twenty-five years later, gender discrepancies persist.

For instance, the Report Card on Gender Equity released by the National Coalition for Women and Girls in Education in June 1997 stated that still "too many girls and women still confront 'No Trespassing' signs throughout educational institutions." Women remain underrepresented in critical areas such as mathematics and science. Mathematics and science have been the focus of considerable attention because these subjects are commonly associated with access to the high-wage, technology-based careers of the future, such as engineering, computer studies, and medicine (Klein & Ortman, 1994). Moreover, American Association of University Women (AAUW), How Schools Shortchange Girls (1992) exposed the lack of female engagement and confidence levels in both mathematics and science in the classroom. In a follow-up study, they reported similar gaps in the area of technology. The newest AAUW report, Gender Gaps: Where Schools Still Fail Our Children (1998), indicated that females lag behind males in their interest in computer studies, enrollment in computer courses, and decisions to major in computer sciences. Girls continue to make decisions not to continue in mathematics and science studies, not because they lack competence, but because they experience "diminished confidence" (Wellesley College Center for Research on Women, 1992, p. 28).
Gifted females, a subset of the female population of learners, are no exception to the larger concern that females are underrepresented in mathematics, science, and technology fields. Because females are intellectually gifted does not necessarily mean they are more likely to demonstrate increased interest in these areas. In fact, Callahan (1979) concludes that gifted females are better "grade-getters," yet often fail to write as many books, earn as many degrees, produce as many works of art, or make contributions in all professional fields. Studies have shown that when gifted females and males are compared, the talented female is less likely to realize her adult potential (Goertzel, Goertzel, & Goertzel, 1978; Callahan, 1981). Therefore, gifted adolescents, were selected as respondents for this research study with the hope that they might not only engage in intellectually challenging activity, but develop their thinking ability and achievements using computer technology.

Efforts toward the improvement of female interest in computer technology has not gone unrecognized by business and industry with well-intended efforts to manufacture and market appealing software for girls. Software products such as Barbie Magic Fairy Tale: Barbie as Rapunzel® and Crayola Magic Wardrobe® are two releases from the increasing list of girl-friendly programs designed to replace shoot 'em up video themes that tend to attract boys. However, the efforts of this research intend to support a more substantial use of computer technology for females. Instead of focusing on fairy tales and clothes closets, this study will describe using authoring software such as Hyperstudio® or m-Power® to build projects and presentations in the development of self-selected interests, which certainly could include content areas such as mathematics and science.

Intentional use of such computer technology authoring programs with design features to add sound, digitized images, graphics, text, video can actively engage learners, especially females, in purposeful and creative endeavors. The potential use technology with a "producer" mentality, rather than a "consumer" mentality may prove to be more appealing than promoting stereotypes with girl-friendly software. Combining audio and video using interactive software
engages the learner in a rich environment using all the senses to provide an environment for the learner to control and manipulate information. With options and buttons to access, navigate, and manipulate the learner can interact with information in order to solve problems based on inference assembled from the learners' prior knowledge base. "The computer can then assess the learner's inference sampling and decide whether the learner has collected an adequate sample and if the conclusion reached is justified. Such systems will allow learners to develop their problem solving skills" (Multimedia, Annual Editions, 1994, p. 138).

Multimedia technologies challenge educators to use applications for curriculum content areas and learning styles of their students. The attention-getting capability of multimedia is undeniable. It is not surprising that multimedia technologies are pervading the classroom. Although many programs excite the imagination with dazzling features and flashy options, educators must harness the power of multimedia technologies to go beyond knowledge and comprehension and build computer literacy skills that invite higher order thinking in relation to appropriate curriculum content.

The potential for increasing female students' problem solving skills and achievement using multimedia technology is possible through interventions inviting female participation and accomplishment. Supported by a most recent comprehensive analysis of hypermedia as an educational technology in the Review of Educational Research (Dillon & Gabbard, 1998), multimedia technology is considered a major advancement in the development of educational tools to enhance learning.

Statement of the Problem

With increased use of computer technology in 1990s schools and classrooms, issues of equity and gender differences in computer use pose new concerns that technology may actually be widening the gender gap, rather than narrowing it. Females are underrepresented in computer courses and elective experiences both in and out of the classroom, have fewer role models encouraging sophisticated uses and applications of technologies from school to work
experiences (Mark, 1992; Kerr, 1994; Hess & Miura, 1985, Damarin, 1996; Beisser, 1997; AAUW, 1998), and see computers as a “male-domain” (Benston, 1988; Turkle, 1988; Sanders, Mark, 1992; Shashaani, 1993). Little existing research investigates the experiences of females using technology for problem solving activity. “There is a need for more process-oriented research focusing on how attitudes, ability, and dispositions for using computers develop” (Kay, 1992, p. 159). In that female students, including gifted students, have been traditionally underchallenged in their understanding and use of educational technology, this study examined the culture of female computer use in and out the classroom with the hope of discovering successful ways in which females may reach their potential.

**Purpose of the Study**

In an effort to impact problem solving skill development and confidence levels of high ability adolescent female students, a multimedia technology summer course was developed for concurrent enrollment of gifted males and gifted females. All students learned to select hardware and software, use multimedia equipment, and complete and present a multimedia project in conjunction with problem solving strategies. The purpose of the study, then, was to interpret computer-related perceptions, behaviors, and attitudes of all students participating in this course. However, because research evidence concludes gender disparity exists in the use of computer technology, particular emphasis was placed on the experience of the female students.

**Grand Tour and Subsidiary Research Questions**

According to qualitative research protocol, an overarching “grand tour research question” (Werner & Schoepfle, 1987) was developed. This question was: “What is the experience of adolescent females using multimedia technology for problem solving skills?” (See Figure 1.) Subsidiary-questions included: How do adolescent females perceive use of computers in their present school environments? How do adolescents perceive computer use
of their male and female peers? What is the self-described computer culture of the adolescent? How do adolescent females assess personal competencies using computer technology? Does multimedia training create meaningful ways for females to interact and to apply learned computer in future experiences? Are adolescents metacognitively engaged in the problem solving process? What future visions of computer technology do adolescent females hold?

Central to the organization of the questions was the possibility of an "engendered" culture of computer use among adolescents. To that extent, many culture-related questions were posed using multiple data gathering techniques such as a pre and post survey, individual and focus group interviews, multimedia project analysis, participant observation, and e-mail exchanges with the respondents (see Figure 2). Interview questions focused on individual perceptions of technology use, as well as that of the students' teachers, parents, peers (see Appendices Figures 1 through 4).

In the following section is a complete description of research methodology and procedures. Sub-sections include research assumptions and rationale, site and sample selections, data collection documents, and data analysis procedures. The results and discussion section precedes the final chapter conclusions.

Methodology and Procedures

I. Assumptions and Rationale

To plan and organize the study, I used Creswell's *Qualitative Inquiry and Research Design: Choosing Among Five Traditions* (1998) and Marshall and Rossman's (1995) formats. While the quantitative approach holds that the researcher should remain distant and independent of that being researched using objective measures, the qualitative stance is in contrast (Creswell, 1994). Using "thick description" (Geertz, 1973) the "lived experience" (Van Manen, 1990) of students enrolled in the Multimedia Mania, is personally described throughout the study. Students revealed their experiences and perceptions using computer
How do adolescents perceive computer use of their male and female peers?

What was the experience of adolescent females' using multimedia technology during summer course to enhance problem solving skills?

How do adolescent females assess personal competencies using computer technology?

What is the experience of adolescent females in this MM course using computer technology?

How do adolescent females perceive use of computers in their present school environments?

Does multimedia training create meaningful ways for females to interact and apply learned computer in future experiences?

What is the self-described computer culture of the adolescent?

Are adolescents metacognitively engaged in the problem-solving process of using computer technology?

What visions of computer technology do adolescent females hold?

Figure 1. Grand Tour Research Question
technology in school and in discretionary environments. Research narratives describe the voice of 20 high-ability high school students with varied background experiences, SES (socioeconomic status) levels, and opinions as they shared their experiences during the multimedia course offered through the Office for Precollegiate Programs for the Talented and Gifted (OPPTAG). This course, hereafter referred to as Multimedia Mania, focused on problem solving strategies and techniques using multimedia software programs and peripheral equipment such as digital cameras and scanners.

My primary role was to observe the context of the course, interpret student learning experiences, and describe female perceptions using computer technology. Acting as an “advocate” (Hamrick, 1997) I tried to communicate the students’ perspectives in order to champion their viewpoint. As a critical theorist, I recognized that interpretation is not possible in a neutral fashion. In order to gain deeper understanding of the respondent’s issues, I became an advocate for change or alternative practices to improve use of computer technology.

To explore gender inequities or dominance of power in cultures of learning and computing, I conducted this research as a critical theorist. Emancipation, empowerment, and social change are goals of a critical theorist. Denzin (1998, p. 332) states the importance of the narrative text of critical theorists.

A critical text is judged by its ability to reveal reflexively the structures of oppression as they operate in the worlds of lived experiences....thus creating space for multiple voices to speak; those who are oppressed are asked to articulate definitions of their situations. Therefore, a good critical emancipatory text is one that is collaborative and naturalistically grounded in the worlds of lived experiences. It is organized by critical, interpretative theory.

Thus, this study created a space for “multiple voices” to speak “of their situations” using computer technology for formal learning and informal communication. The “lived experiences” (Van Manen, 1990) of the respondents formed the body the narrative reported in the results and discussion. “Lived experiences” of students are important because phenomenological human science begins in lived experiences and eventually turns back to it” (p. 35). Important to the design of this study, is understanding “feminist methodology”
(Bloom, 1998) in order to help both the researcher and the respondent to generate a unique context in which to study the lives of females. "Through the research process they may unlearn silences, prejudices, and fears of conflict" (p. 56).

II. Site and Participant Selections

A non-random convenience sample for this study was composed of 20 gifted adolescent students attending a 30-hour elective summer course in multimedia technology at Iowa State University, a large midwestern university. Respondents had typically completed junior high school and were early high school students from different Midwest schools varying in district size from under 350 to over 1350 students (see Tables 1 and 2). This sample represents a very balanced distribution of bright students from a variety of high schools in the Midwest. Not all gifted students came from secondary schools of similar size or composition.

Table 1. Demographics Describing Multimedia Mania Respondents

<table>
<thead>
<tr>
<th>Grade</th>
<th>Age</th>
<th>Gender</th>
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<tbody>
<tr>
<td>5 students in 8th grade</td>
<td>5 students 13 years old</td>
<td>15 Females</td>
</tr>
<tr>
<td>12 students in 9th grade</td>
<td>13 students 14 years old</td>
<td>5 Males</td>
</tr>
<tr>
<td>3 students in 10th grade</td>
<td>1 student 15 years old</td>
<td></td>
</tr>
<tr>
<td>0 students in 11th grade</td>
<td>1 student 16 years old</td>
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</table>

* N = 20 students

All students had formally enrolled in the tuition-supported elective program offered by OPPTAG, a residential summer institute of various course offerings. Students participating in this study were enrolled in an introductory multimedia technology course in the June 1998 session. In Multimedia Mania, a 30-hour non-credit course designed to develop problem solving skills, students used media enhanced technology for the creation of an electronic project in a self-determined interest area.
Females were encouraged to participate in the OPPTAG EXPLORATIONS! Multimedia Mania workshop was provided through the distribution of an informational one-page flyer. (See Appendix C.) The flyer invited females to enroll in computer technology courses, which typically fill with males. Included in the flyer were details of various summer computer classes at Iowa State University. Flyers were mailed to surrounding high school academic counselors and gifted education coordinators. Recipients were asked to post or distribute flyers in junior and senior high schools. Additional flyers were handed out at a state-wide science fair and at a precollegiate Career Explorations Program, both held on the local university campus. Approximately 3000 females in grades 8-10 in the Iowa Talent Search multi-state area were informed through distribution of the flyers.

In an effort to support females who wished to attend the OPPTAG EXPLORATIONS! Multimedia Mania workshop, but lacked sufficient finances in order to enroll, four scholarships were organized through educational foundations and donations. Financial contributions were provided from the EXXON Education Foundation, Delta Kappa Gamma International Honorary for Women, the Iowa State University Foundation, and the Lynn Glass Memorial Foundation Scholarship. Scholarship availability and computer course dates and

<table>
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<th>Table 2. Description of High School and Class Size</th>
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<tr>
<td>High School Size</td>
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<td>----------------------------</td>
</tr>
<tr>
<td>High School Size</td>
</tr>
<tr>
<td>Graduating Class Size</td>
</tr>
</tbody>
</table>

\(^a\) VL = Very large high school of over 1350 students  
VL = Very large graduating class of over 300 students

\(^b\) L = Large high school of 800-1350 students  
L = Large graduating class of 175-300 students

\(^c\) M = Medium high school of 350-800 students  
M = Medium graduating class of 75-175 students

\(^d\) S = Small high school of under 350 students  
S = Small graduating class of under 75 students
times were included in the flyers. Scholarship applications were mailed to interested applicants upon their request (see Appendix D). Four scholarship recipients were selected on the basis of financial need, letters of recommendation, and commitment to attend the summer Multimedia Mania course. All four female students were awarded full tuition scholarships. The EXPLORATIONS! Multimedia Mania class rapidly filled with 20 eligible students, 15 females and 5 males. Eligibility for EXPLORATIONS! required students to have completed grades 7-10 and scored at or above the 97th (national norms) or 93rd (Iowa norms) percentiles on subtests of the Iowa Test of Basic Skills (ITBS), Iowa Tests of Educational Development (ITED), or any other standardized achievement test. All 20 enrollees met or exceeded these requirements, including the four female scholarship recipients.

Approval for the research study was received in February, 1998 from the Iowa State University Human Subjects Committee (see Appendix M). Enrollees were sent an interest inventory (see Appendix I) in order to maximize development of an electronic project in an area of skill and interest. The Use of Computers and Multimedia Technology (UCMT) survey, along with a letter of consent (see Appendix E) and a letter of welcome (see Appendix F) explained the course proceedings to students and families. Voluntary participation and withdrawal from the study at any time was explained to the participants. All data from comments and coursework was kept confidential. Students sent completed forms back to the ISU OPPTAG office in a timely manner prior to the first day of the multimedia course. A research timeline established overall direction for the project (see Appendix O).

III. Data Collection Documents and Procedures

Data was collected from multiple sources (see Figure 2) in order to gather feedback to clarify interpretations of student experiences using computer technology. Drawing upon David Jonassen's (1996) research in *Computers in the Classroom: Mindtools for Critical Thinking*, I developed a survey to conceptualize computing experiences as a way to engage learners in
Figure 2. Data Sources: Adolescent Student Perceptions about Computer Use
constructive, critical processes of thinking about their classroom curriculum. Jonassen's work influenced this study by depicting multimedia and hypermedia as powerful representation "mindtools" for learners to design, solve problems, and make decisions.

As described later detail, the multiple data collecting sources included participant observation, individual interviews, focus group interviews, participant journaling, a survey, and follow-up e-mail checks with the respondents. The Use of Computers and Multimedia Technology (UCMT) survey (see Appendix G), had a total of 38 items divided into four parts.

A. UCMT Survey Questionnaire with four parts was administered prior to the course

Part 1: Demographic Information

Part 2: Computer Experience

Part 3. Multimedia Technology Experience

Part 4: Multimedia Self-Efficacy

Part 1 of the survey (see Appendix G) provided participant demographic data including gender, grade, age, district size and class size. Survey Part 2 (see Figure 3) provided background about student's computer technology instruction and multimedia technology instruction. A sample question is shown in Figure 3.

**Item #6. Computer Technology Instruction:**

What exposure have you had in using computers in learning? (Check all that apply)

- [ ] Taken a semester credit class during school (computer programming or keyboarding).
- [ ] Taken a class out of school (college class, community education, summer, etc.).
- [ ] Had technology instruction during class, but not a whole semester of training.
- [ ] Had technology instruction as part of another subject (such as science or reading).
- [ ] No formal instruction—I figured it out alone or with peers.
- [ ] No use of computers whatsoever.

Figure 3. Survey Part 2 Sample Question on Technology Instruction
Source: Use of Computers and Multimedia Technology (UCMT) survey Part 2; Appendix G.
Part 3 of the survey provided data (see Figure 4) about student skills and experiences using technology. Knowing the extent of previous experience using computer technology, especially multimedia technology, was important in order to determine the difficulty level of the Multimedia Mania summer course. Sample questions are shown in Figure 4.

### Survey Part 3: Multimedia Technology Experience

1. **Please indicate multimedia software you have used (Check all that apply).**

   - HyperStudio®
   - Power Point®
   - m-Power®
   - Digital Chisel®
   - Linkway®
   - Authorware®
   - MacroMedia Director®
   - Astound®

   **Other:**
   - Web page authoring software

2. **What skills have you used in multimedia technology? (Check all that apply).**

   - Added text (words, titles, phrases, etc.)
   - Added graphics (images, pictures, icons)
   - Scanned in graphics using a scanner
   - Added sound from a sound file
   - Recorded my own sound
   - Connected buttons to documents / applications
   - Made “buttons” for non-linear navigation
   - Connected a program to Internet sites
   - Created new cards, stacks, slides, pages
   - Used a digital camera for photographs
   - Imported video or movie graphics
   - Created or drew my own graphics
   - Created my own animation
   - Created my own video with editing equipment
   - Created my own WWW homepage.

3. **What processes have you used in multimedia technology? (Check all that apply).**

   - Developed a topic or theme using multimedia software and additional technologies.
   - Developed links for navigation of the project.
   - Developed non-linear trail to navigate a project independently
   - Used time management skills to complete a multimedia project in a timely manner.
   - Used concept mapping to sketch ideas on paper before developing them electronically.
   - Used research skills for information and content to build ideas.
   - Used organizing and planning skills to represent ideas.
   - Used reflection to think about the multimedia project during and after working on it.
   - Used presentation skills to share the project with an appropriate audience.
   - Used knowledge to construct (think of) my ideas in a multimedia project.
   - Used knowledge to represent (depict) my ideas in a multimedia project.

---

Figure 4. Survey Part 3 Sample Question on Multimedia Technology Experience
Source: Use of Computers and Multimedia Technology (UCMT) survey Part 3; Appendix G.
Jonassen's (1996) research in *Computers in the Classroom: Mindtools for Critical Thinking* was important in the development of the process skill items in part three of the survey. His work increased my understanding that use of multimedia technology required learners to sketch out a concept map before electronically developing a project, to use research skills for content, to organize and plan ideas, to reflect on the project, and to present it to an appropriate audience. His work on electronic construction and representation of ideas, influenced the way the multimedia course was designed to challenge student reasoning and problem solving.

Part four, addressing multimedia self-efficacy, was drawn from the literature (Bandura, 1981; Schunk, 1991; Pajares, 1996). Items required students to report levels of self-efficacy in selecting hardware and software, using multimedia equipment, and completing and presenting a multimedia project. A Likert scale was used to report levels of confidence. This section was given before and after the multimedia course. See Figure 5 for a sample item.

**Survey Part 4 Multimedia Self-Efficacy**

*Directions:* Below you will find a number of statements concerning your confidence using multimedia-capable digital technology. Please circle the number below that best describes how you feel about each statement using the 4-point scale provided.

<table>
<thead>
<tr>
<th>My confidence level for performing this task is:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not confident</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

**Selecting Software and Hardware:**

1. Choosing appropriate software to create a multimedia project. 1-2-3-4
2. Knowing if my computer can support the software for a multimedia project 1-2-3-4
3. Using multiple floppy disks or a zip disk and zip drive to store & save the project. 1-2-3-4
4. Knowing what accessories to use to incorporate more elements into the design. 1-2-3-4

*Figure 5. Survey Part 4 Sample Question on Multimedia Self-Efficacy*

Source: Use of Computers and Multimedia Technology (UCMT) survey; Part 4; Appendix G.

The completed survey was field-tested with high school students in the Fairfield Community Schools under the supervision of their district technology coordinator. Subsequent changes made in words and phrases increased clarity of the instrument. In order to interpret collected data, Chapter 4 tables provide demographic data and descriptive statistics of
means and standard deviations for survey pre and posttests. A non-parametric statistical test, the Wilcoxon Signed Ranks Test, compares student pretest and posttest survey scores.

A multimedia project rubric, was used to evaluate students final electronic projects. (See entire assessment tool in Appendix K.) Credit for the assessment tool should be given to Mike Nieland, Heartland Area 11 Educational Agency. To reflect the course goals and content, the tool was revised. There were 104 points possible in 13 performance categories that included physical display and documentation, content, goals & objectives, language use, organization, user engagement, creativity, program features for use of visuals, text and sound, media integration, oral presentation, and overall merit. A scale of 1-8 was assigned with 8 as the highest score possible. Each student received multimedia project evaluations using this tool from two different raters. See Table 3 for a sample assessment item from the rubric.

<table>
<thead>
<tr>
<th>Table 3. Multimedia Assessment Tool Sample Item</th>
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<tbody>
<tr>
<td><strong>Category</strong></td>
</tr>
<tr>
<td>PHYSICAL DISPLAY &amp; DOCUMENTATION</td>
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<tr>
<td></td>
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Source: Multimedia Assessment Tool; Appendix K.

In order to interpret collected data, descriptive statistics provided means and standard deviations for multimedia project evaluation scores. A non-parametric statistical test, the Wilcoxon Signed Ranks Test, compared rater 1 and rater 2 evaluation scores. A correlation of rater 1 and 2 scores was computed using the Pearson Product Moment correlation. Descriptive tables and statistic sections are included in this document and in the Appendices. (See all Tables in Chapter 4 and Appendix A and Q.)
B. Semi-structured Individual interviews

Interviews with each of the 20 students enrolled in Multimedia Mania yielded information about the student's prior experiences with computer technology, training and skill development, and personal observations or perceptions of how computers are used by males and females in their school and out of school settings.

C. Participant Observation

At various times throughout the 30-hour course instruction and during informal breaks, I took notes and observed behaviors, conversations, on-task and off-task conduct, and male/female participation throughout the class. Observations were recorded in a journal for coding and analysis.

D. Journaling and homework assignments completed independently of instruction.

Students were asked to maintain a journal of their perceptions as they participated in the multimedia class. The purpose of their reflective journals was twofold: to get students to internalize and think through what they believe about computers, gender, and problem solving. They served as a record of their thought processes with regard to constructing their multimedia projects and how their thoughts changed as they completed their projects. It should be noted that homework was expected each evening for all students enrolled in the OPPTAG classes, which were residential courses for the participating students housed in the university dormitories (see Appendix J).

E. Document Review: A Scoring Rubric to evaluate each Final Multimedia Project

With two trained raters observing the student's final media presentation on the final day of instruction, each student had a scored analysis of their electronic presentation. A rubric (See Appendix K) provided an evaluation of the content, multimedia components, and presentation effectiveness. The rubric was designed to coordinate with the goals and objectives of the multimedia course. Each student received by mail a copy of the scores from the raters after the course was completed.

F. Focus groups (3 groups of 6-8 students) conducted by RISE

The Research Institute for Studies in Education (RISE) in the College of Education conducted focus groups at the end of the course. I conducted a preliminary training session with the RISE staff prior to their interaction with the students. The purpose of the training was to inform the interviewers and recorders of the nature of the focus group questions and the quality of responses which might shape the group interview conversations. Questions focused on problem solving and gender. (See Appendix L.)

G. Follow-up Communication with multimedia participants and families

In accordance with qualitative research protocol, follow-up questions and clarifications based on data analysis were directed to respondents as emerging themes developed in the analysis process. The request for continued contact was approved by the Human Committee. A summary of activity was mailed to participants and families at the end of the course (see Appendix H). After an extended period, participants were invited
to continue the research study for a $20 honorarium (see Appendix N) with 90% of the students choosing to respond, a surprisingly high response rate.

IV. Data Analysis Procedures

The Multimedia Mania course was designed collaboratively with the facilitating instructor, Jason K. As a former student in my university methods course, Jason had been my technology mentor in a semester-long program offered through the ISU Curriculum and Instruction Department. Because we found mutual benefit in the mentor-mentee relationship, we continued a second semester working together on use of multimedia technology. In a joint effort, we developed the course and the training materials using multimedia software, problem solving strategies, ethics in development of an electronic project, and presentation techniques (see Appendix J). Jason is currently employed as a district technology coordinator in a medium-sized Midwest public school. We agreed that he would provide instructional leadership during the course along with 2-3 lab assistants from Iowa State University, while I conducted field research. In addition, three university students enrolled in Elementary Education 580B, a field-based preservice teaching experience, were assigned to work individually with the course participants. Deb, a graduate student, and Denise, guest lecturer and associate director of the ISU Center for Technology in Teaching and Learning (CTLT), provided instruction and lab expertise. All members conferred daily after class to make decisions for instruction the following day.

Collected data resulted from observing students, conducting and transcribing 20 personal student interviews, three focus groups during the course. Focus group interviews were conducted by Research Studies in Education (RISE) staff. For nearly a year following the summer study, I exchanged and transcribed e-mail messages. Students were asked to assume alias names to assure confidentiality of their multimedia project development and follow-up communication (see Appendix Table 1 and Appendix Figure 5). I have amassed 690 total pages of raw data (see Appendix R) including student interviews, student journals and drawings, final electronic final projects using with Hyperstudio® or m-Power®, scored
rubrics from the presentation of the final projects, and transcribed observations of the students. Using FolioViews 3.1® computer software for data management, 15 different themes emerged describing influences of early life and parental support, gender stereotypical behaviors, levels of female and male competence and confidence using computer technology, self-instruction using technology, school-related experiences, problem solving with computers, and the "engendered" culture of computer use among adolescents (see Appendix Q). Collapsing these 15 themes into seven primary themes resulted from analysis and combining similar issues, eliminating duplicity of themes, and editing superfluous ideas.

A coding system (Bogdan & Biklen, 1998, pp. 173-177) was used to analyze all observations, individual and focus group interviews, and respondent feedback data. The following codes provided "categories of themes" to sort data. This method was conceptually manageable and mechanically feasible in structuring the data analysis process.

1) Setting/Context Codes: (General information on campus site, computer lab, problem solving, multimedia course planning and instruction); 2) Definition of Situation Codes: (Worldview of respondents; how they see themselves relative using computers in and out of school); 3) Perspectives Held by Students: (Use of computers by self, peers, parents, teachers, and self-appraisal of technology skills); 4) Respondents' Views of Thinking about People and Objects: (View of computers and technology use relative to gender); 5) Process Codes: (Sequence of events, changes over time, steps, stages, passages, chronology); 6) Activity Codes: (Behaviors in and out of class during the week; Use of discretionary time); 7) Strategy Codes: (Problem solving methods, techniques, attitudes using multimedia technology); 8) Relationships and social structures: (Patterns among students in the course such as roles and positions).

Conclusive statements were drawn from data comparing and contrasting, transcribed documents, noting patterns and themes, and clustering ideas. Confirmation included
"triangulation" using multiple data sources. I looked for negative cases, follow-up surprises, and checked assumptions with respondents (Huberman & Miles, 1998).

Results and Discussion

Multimedia Final Project Evaluation

Evaluation of each of the 20 final multimedia projects, using the multimedia assessment rubric (see Appendix K), resulted in project score means of 75.1 from rater 1 and 81.2 from rater 2 (see Table 4). Rater 2 gave higher scores to 18 of the student's final projects, while rater 1 gave a higher score to one student, and both raters gave the same score only once. Using the Wilcoxon Signed Ranks Test (see Table 5) for the raw score differences of rater 1 and rater 2, ranked scores were highly significant. In other words, there was little statistical difference in the student's scores given by the two raters, with rater 2 giving consistently higher scores.

Table 4. Descriptive Statistics for Multimedia Mania Project Scores by Raters

<table>
<thead>
<tr>
<th>Rater 1</th>
<th>N</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Scores</td>
<td>20</td>
<td>75.8</td>
<td>12.24</td>
<td>51</td>
<td>92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rater 2</th>
<th>N</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Scores</td>
<td>20</td>
<td>81.2</td>
<td>11.83</td>
<td>59</td>
<td>96</td>
</tr>
</tbody>
</table>

Table 5. Wilcoxon Signed Ranks Test for Raters

<table>
<thead>
<tr>
<th>Difference</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Raters</td>
<td>1</td>
<td>5.50</td>
<td>5.50</td>
</tr>
<tr>
<td>Rater 1 and</td>
<td>18</td>
<td>10.25</td>
<td>184.50</td>
</tr>
<tr>
<td>Rater 2 Raw</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Raw Scores</td>
<td></td>
<td>Total</td>
<td>20</td>
</tr>
</tbody>
</table>

*a Rater 2 Raw Scores < Rater 1 Raw Scores
*b Rater 2 Raw Scores > Rater 1 Raw Scores
*c Rater 1 Raw Scores = Rater 2 Raw Scores
*d Level of Significance of Wilcoxon Signed Ranks Test Statistics $p = < .001$
To compare the two rater's scores, a correlation coefficient \((r = 0.94)\) was calculated for rater 1 and rater 2 for the student's Multimedia Mania Electronic Project scores (see Table 6). Raters had a highly positive correlation in scoring student's projects. Scores were mailed to the each of the respondents at the end of the multimedia course.

### Table 6. Multimedia Mania Electronic Project Scores** (N = 20)

<table>
<thead>
<tr>
<th>Student Code#</th>
<th>Rater #1 Scores</th>
<th>Rater #2 Scores</th>
<th>(\bar{X}) by Student Topic Choice</th>
<th>Gender</th>
<th>Student Topic Choice for Multimedia Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 (males)</td>
<td>80</td>
<td>88</td>
<td>84</td>
<td>84.8</td>
<td>Dragons</td>
</tr>
<tr>
<td>M2</td>
<td>92</td>
<td>92</td>
<td>92</td>
<td></td>
<td>Jimi Hendrix</td>
</tr>
<tr>
<td>M3</td>
<td>71</td>
<td>67</td>
<td>69</td>
<td></td>
<td>Vincent Price</td>
</tr>
<tr>
<td>M4</td>
<td>87</td>
<td>95</td>
<td>91</td>
<td></td>
<td>Boy Scouts of America</td>
</tr>
<tr>
<td>M5</td>
<td>86</td>
<td>90</td>
<td>88</td>
<td></td>
<td>Simpsons</td>
</tr>
<tr>
<td>F1 (females)</td>
<td>91</td>
<td>96</td>
<td>94</td>
<td>76.7</td>
<td>North American Wolves</td>
</tr>
<tr>
<td>F2</td>
<td>80</td>
<td>82</td>
<td>81</td>
<td></td>
<td>Walt Disney</td>
</tr>
<tr>
<td>F3</td>
<td>74</td>
<td>79</td>
<td>77</td>
<td></td>
<td>Infant Brain Development</td>
</tr>
<tr>
<td>F4</td>
<td>72</td>
<td>85</td>
<td>79</td>
<td></td>
<td>Dolphins</td>
</tr>
<tr>
<td>F5</td>
<td>60</td>
<td>66</td>
<td>63</td>
<td></td>
<td>Cardinals Baseball Team</td>
</tr>
<tr>
<td>F6</td>
<td>87</td>
<td>90</td>
<td>89</td>
<td></td>
<td>Horses</td>
</tr>
<tr>
<td>F7</td>
<td>81</td>
<td>93</td>
<td>87</td>
<td></td>
<td>Paris</td>
</tr>
<tr>
<td>F8</td>
<td>57</td>
<td>68</td>
<td>63</td>
<td></td>
<td>Cats and Outerspace</td>
</tr>
<tr>
<td>F9</td>
<td>86</td>
<td>87</td>
<td>87</td>
<td></td>
<td>Mount Vernon, Virginia</td>
</tr>
<tr>
<td>F10</td>
<td>71</td>
<td>79</td>
<td>75</td>
<td></td>
<td>Constellations</td>
</tr>
<tr>
<td>F11</td>
<td>91</td>
<td>96</td>
<td>94</td>
<td></td>
<td>Chicago Bulls</td>
</tr>
<tr>
<td>F12</td>
<td>70</td>
<td>77</td>
<td>74</td>
<td></td>
<td>Mars</td>
</tr>
<tr>
<td>F13</td>
<td>62</td>
<td>64</td>
<td>63</td>
<td></td>
<td>Monty Python</td>
</tr>
<tr>
<td>F14</td>
<td>66</td>
<td>71</td>
<td>69</td>
<td></td>
<td>Earthly Elementals/Mythological Animals</td>
</tr>
<tr>
<td>F15</td>
<td>51</td>
<td>59</td>
<td>55</td>
<td></td>
<td>Gemstone3</td>
</tr>
</tbody>
</table>

** Total points possible = 104 pts in 13 categories with 1-8 pt range for each category.

---

In summary, the multimedia project rubric evaluations revealed a relatively wide spread of scores, from 51 to 96 points. A highly positive correlation of rater's scores indicated agreement between raters of the general quality of student work. Project topics varied from Vincent Price to Monty Python and Cats to Constellations. Identity of students was protected.
by reporting project titles, rather than their names. Interestingly, the mean of male scores was higher (84.8) than the female scores (76.7) after the course had been completed.

**The Use of Computers and Multimedia Technology (UCMT) Survey**

As an indicator of student skill development and self-efficacy, The Use of Computers and Multimedia Technology (UCMT) Survey Part 4 on self-efficacy (see Appendix G) was given as a pre and post measure before and after the Multimedia Mania course. Students reported self-efficacious levels (from “not confident” to “extremely confident”) in selecting hardware and software, using multimedia equipment, completing, and presenting a multimedia project. As an internal evaluation of the self-efficacy Part 4, mean differences were calculated for the sub-sections. Differences were very slight among the three sub-sections with selecting software and hardware reported as .66, using multimedia equipment at .70, and completing and presenting a multimedia project at .68. A grand mean of differences was calculated at .68. Therefore, students reported their skills as consistent in ability to use equipment and to develop multimedia projects. (See Table 7.)

<table>
<thead>
<tr>
<th>Survey Sub-Sections</th>
<th># Survey items</th>
<th>Mean of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selecting</td>
<td>4 items</td>
<td>.66</td>
</tr>
<tr>
<td>Using</td>
<td>10 items</td>
<td>.70</td>
</tr>
<tr>
<td>Completing/Presenting</td>
<td>11 items</td>
<td>.68</td>
</tr>
<tr>
<td>Totals</td>
<td>25 items</td>
<td>.68</td>
</tr>
</tbody>
</table>

* Selecting Software and Hardware
* Using Multimedia Equipment
* Completing and Presenting a Multimedia Project

Students' pre and post self-efficacy scores, clearly indicated that after completing the Multimedia Mania course, they experienced increased levels of confidence in selecting, using, completing, and presenting a multimedia project. Pretest and posttest means were 2.5 and 3.2 respectively (see Table 8).
The Wilcoxon Signed Ranks Test (see Table 9) of 265 test items indicated a highly significant increase in skills and confidence in selecting, using, completing, and presenting a multimedia project after completing the course. The entire UCMT survey appears in Appendix G.

Table 8. Descriptive Statistics for UCMT Student Pretest and Posttest

<table>
<thead>
<tr>
<th>Item</th>
<th>#Survey items</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum Item Score</th>
<th>Maximum Item Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>500</td>
<td>2.5</td>
<td>.998</td>
<td>1.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Posttest</td>
<td>500</td>
<td>3.2</td>
<td>.779</td>
<td>1.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>

*500 items=20 students x 25 items on each survey questionnaire

Table 9. Wilcoxon Signed Ranks Test* for Student Pretest and Posttest

<table>
<thead>
<tr>
<th>#Survey items</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>The difference between posttest and pretest self-efficacy scores</td>
<td>* Negative Ranks</td>
<td>46*</td>
</tr>
<tr>
<td></td>
<td>* Positive Ranks</td>
<td>265*</td>
</tr>
<tr>
<td>* Ties</td>
<td>189*</td>
<td></td>
</tr>
<tr>
<td>* Total</td>
<td>500*</td>
<td></td>
</tr>
</tbody>
</table>

* POSTTEST < PRETEST
* POSTTEST > PRETEST
* PRETEST = POSTTEST

N=20

*500 items=20 students x 25 items on each questionnaire
* Level of Significance of Wilcoxon Signed Ranks Test Statistics p = <.001

Using the Wilcoxon Signed Ranks Test for student pretest and posttests, male self-efficacy, as reported on the Computers and Multimedia Technology (UCMT) post-test scores, was significantly higher than the females' self-efficacy scores (see Table 10).

In summary, after completing the summer multimedia course, both males and female students reported greater levels of confidence in developing multimedia technology skills. Males, however, significantly rated themselves as “confident” to “extremely confident” while females rated themselves as “a little confident” to “confident” after the same 30 hours of multimedia technology training.
Table 10. Wilcoxon Signed Ranks Test\textsuperscript{b} for Pretest and Posttest by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>#Survey items</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>125</td>
<td>294.41</td>
<td>36801.50</td>
</tr>
<tr>
<td>Female</td>
<td>375</td>
<td>235.88</td>
<td>88448.50</td>
</tr>
<tr>
<td>Total</td>
<td>500\textsuperscript{a}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a} 500 items=20 students x 25 items on each questionnaire
\textsuperscript{b} Level of Significance of Whitney-Mann Test Statistic for gender p = <.001

Narrative Summary of Triangulated Data:

There is more to understanding the nature of computer use among gifted adolescent students than the measured increases in skill at high levels of significance using multimedia technology during the Multimedia Mania course. Interpreting the “lived experiences” (Van Manen, 1990) shared by the respondents, particularly the females, resulted in interesting views exposing an “engendered” culture of computer use among the students. Incorporating student experiences using “thick descriptions” (Geertz, 1973) eliminated quantified numbers without faces and emotions. The following narrative will speak to the human nature of the adolescent respondents in this study in order to understand their perspectives. It's not an easy task, however, to share human nature validly and vividly. After collapsing the 15 original themes into more succinct themes, the following seven major ideas support the learning and computing experiences and issues of the adolescents in the study:

1. Early life and early school experiences and family support were powerful influences on computer-savvy teenagers. Many students in this study now have more advanced computer skills than their parents.

2. Gender stereotypical behaviors exist for bright females in the study whether they were using computers for intentional or recreational purposes.

3. Females in the study valued rich experiences using computer technologies in ways that were personally meaningful over time and were positively influenced by interaction with computer-using peers.
4. Gifted adolescent students in this study insisted there were no gender differences in male-female use of computer technology among their teachers, peers, or parents. However, their interview narratives provided interesting evidence to the contrary.

5. While bright adolescents in this study found some educational computing school experiences relevant, most reported that they were largely self-taught and that their classroom teachers lacked necessary computer skills.

6. Gifted students in the study were generally impatient with problem solving instruction. Individuals who valued problem solving seemed to hold greater capacity for developing complex ideas using computer technology as a tool.

7. Adolescents in this study interact in a computer-culture of their own definition outside of the world of adults and perceive application of computer skills to their future career goals.

A detailed discussion of these seven narrative themes follows in the segments below.

1. **Early life school experiences and family support were powerful influences on computer-savvy teenagers. Many students in this study now have more advanced computer skills than their parents.**

   Experiences of computer-savvy teenagers originate in their elementary years, whether in the school or in their homes. Students recall early school introduction to computers in their kindergarten classrooms. Sarah, a ninth grade girl with well-developed skills using various multimedia software programs, recalls early childhood use of those “tan Apple® computers” to play games like Layer Cake. “You had to choose how many layers you wanted on your cake and then you had to stack three piles with the fewest steps you could use to stack the cake.” Interestingly, even in early childhood she understood that there were logic strategies required in game-playing. A reserved ninth grade female, Alicia, doesn’t have any specific early childhood computer memories, but recalls going to the school computer lab since kindergarten. While Rachael, now a high school sophomore, has no idea the first time she used a computer, but has been a regular user since age 6 or 7. She started at home with Apple computers with “green screens.” She stated, “Surprisingly, they were better than the ones I got in Junior High, that we used mostly for typing up reports and drawing pictures.” Jessica’s first
experience was in her mother’s high school classroom. She wanted to be like the big kids, so she pressed and typed a “whole bunch of buttons and froze up the computer.”

“My mom just keeps warning me about how she doesn't want me to freeze up the computer again. She tells me that story all the time. That’s my first computer use.” (Jessica, female, grade 9)

Other students recalled first experiences from their home environments. Many parents provided hardware and software for educational exploration. Laura’s first experience was at age 5 or 6 using educational games when her parents bought their first computer. As a ninth grader, she now uses computers more for schoolwork, but not for computer games. Chris, one of the males in the study, remembered early childhood computer games.

“My first experience with a computer was probably when I was seven and we had just got a new computer, and it was like top of the line then, and I was like playing Solitaire and games like that on it.” (Chris K., male, grade 8)

Chris continues to play a variety of computer games as an adolescent. Eric K., a ninth grade male, described his first experience in his home when he was in the fourth grade. His dad brought a computer home on loan from work at Farm Bureau in Des Moines. He introduced him to a lot of educational software and mathematics games. Like Chris, Erik continues to play computer games in high school.

“My first computer use would’ve been when my parents got this Apple IIE. I think they got me this Big Bird Sesame Street thing. We don’t have it anymore, but that’s what I remember playing first.” (Jackie, female, grade 9)

Jackie, like most of the participating adolescent females, did not emphasize playing computer games either in early childhood or as an adolescent. Liz, an intense game-playing ninth grade girl, was interested in becoming a computer programmer. She says, “I have my own web page, but I don’t like to give out the address because I haven’t updated it for a few years. I was probably sixth grade the last time I updated it.”

Students commented that their fathers helped them acquire and develop computer skills.

“Sometimes my dad will try to teach me and my sister how to use software that he brings home from work. He will sometimes do presentations for companies. He is part of Toastmaster. He gives speeches and presentations and stuff. Every
once in a while he will bring home a laptop for work and he does his presentations.”  
(Eric B., male, grade 9)

“I started a Gemstone3® two week free trial and now I have to pay. I bring my dad money and he just uses his credit card to pay for it. It’s ten dollars a month for just one RPG (role-playing game) character. For $20 a month you can have as many as you want, so it’s not that bad.” (Liz, female, grade 9)

Alli’s dad helped her use search engines while Chris’ dad consulted him in purchasing decisions. Kristen’s dad made software decisions because “he knows what will run on our computer and how well it will function” such as a Pentium II for their Gateway. It seems critical that the fathers were instrumental decision-makers. One even consulted his son, in particular, for software information. More students credited their mothers as being influential in encouraging computer instruction using software, developing Websites, and making decisions about hardware purchases.

In Kate’s house, her mom was in charge of computer purchases although Kate “helps out a lot.” Her dad and brother use computers, but “don’t really know a lot about them, other than to get them to do what they want.” Eric’s mom facilitated his home e-mail account because it required long-distance phone calls. Jessica’s mom taught her Hyperstudio®, Kelsey’s mom told her about search engines, and Alli’s mom taught her PowerPoint®.

“My mom introduced me to technology. I probably wouldn’t have the background I have without her. Every time she got a new program or saw something new she’d say, ‘Sarah, come here. I want you to see this.’ And I would learn how to use it.” (Sarah, female, grade 9)

“Well, actually, my mom has set up a web page, and I can have one, but it is a link from hers, because she is a traveling consultant for computer statistics company” (Jake, male, grade 9)

“Usually it’s my mom who decides on what we plan to buy with regard to computers and computer equipment. We have four computers—a Gateway 2000, a Texas Instruments, a Zenith Data Systems, and an old Apple which we don’t use very much anymore.” (Liz, grade 9)

Other students credited both parents as influencing software and hardware use and purchases in their home. Jessica and Kelsey stated both parents decide what computer hardware and software to purchase. It becomes “a huge dispute” between Jessica and her
brothers about who decides what games or programs to buy. Usually her brothers win. In Alli and Nicole’s houses, the parents decide about hardware purchases, but the kids decide what kind of software they want. Mary purchased software herself, if her parents wouldn’t buy it for her. Alli didn’t request any software, but used what her parents already purchased. Rachael, a bright opinionated student who used “countess” as an e-mail account name, thinks her parents should update their equipment.

“My parents both buy a lot of educational and recreational software for me. We recently decided to get a new computer. I wanted to get a Macintosh G3, but my mom decided upon a purple iMAC instead. Sometimes I decide upon what we need, such as a new modem because our old one is dead.” (Rachael, female, grade 10)

Students reported that they had specific influence over their parents’ computer use, knowing their parents were not as computer literate as their children. Some students reported helping their parents learn new skills. For example, Stacia and Laura’s parents ask them for computing assistance because, as adults, they have less developed computing skills than their children. Mary, grade 8, says neither her mom or dad “want to use the computer at all.” In fact, she has to check their e-mail and print off messages for them. Alli, an articulate ninth grader, is “the deciding factor” when it comes to games. She tells her parents what to purchase and they apparently do so.

Mary and Alicia, ninth grade girls, were both Multimedia Mania scholarship recipients. Their parents encouraged them to take the out-of-school Multimedia Mania class to learn new uses of computers. “My parents are both computer illiterate. My dad is a farmer and doesn’t care, but my mom is interested in learning about the computer,” stated Alicia.

“At home we have not purchased any new equipment, I am still helping my parents learn how to use what we have. My school bought a couple of iMacs and laptops for our new computer lab. Our school also purchased a zip drive, but students are not allowed to use it even if they have their own zip disk.” (Alicia, female, grade 9)

Justin explained that his mom does not “get computers,” not because she isn’t intellectual, but “because she is not used to using computers.” He attributed lack of computer experience to his mother’s gender, not her lack of intelligence.
"I definitely try to teach my mom about computers. I mean, I’m not saying she’s not smart. But she just wouldn’t get it. Because they [females] are just not used to it.” (Justin, male, grade 10)

Chris has developed more advanced computing skills than his father. He was interested in sharing his skills, however, to help his dad in his world of work.

"I use the computer much more than my dad. And I think I know more than him, too. Because one time I was just—I think it was last summer—I was just messing around on the computer. I built him a web page and called him up at work and asked him if he had access to the Internet. That way he could go look at it.” (Chris, male, grade 8)

Financial constraints prohibited some students from having much freedom using computers fully. Melisa said that “whoever is paying,” whether she or her parents, ultimately determined what to buy based on discussing the actual need for the purchase. In Alicia’s case, she needed to provide rationale in order for father to agree to home computer purchases.

"Actually our financial situation decides what we can buy for home. My dad needs to see relevance in buying different things, and he isn’t very computer literate so it’s hard to convince him to purchase anything.” (Alicia, female, grade 9)

Finally, students reported that while a majority of their schools had Macintosh computers installed in labs and classrooms, they used PCs at home for homework and leisure pursuits. Eighty percent of the students responded in the Use of Computers and Multimedia Technology (UCMT) Survey questionnaire (see Appendix G), that they used Macintosh computers and school, while 80% of the students reported that they used PC computers at home. Chris states, “My school basicly (sic) only uses Macintosh’s. I would like them to have IBM compatibles and better software. At home I use a Dell.” Similarly Mary says, “At school we have Macs, but at home we have a Gateway.” “At my house I used a Compaq Presario and at school, we use only Macs,” reports Stacia. Melisa states, “We have a brand new Compaq Presario at home and Macs at school.” While these students merely stated the kind of computers at home at school, some students were more vocal about the presence of Macintosh computers in their school environment.

“We have all Apple II’s at school and they all really suck. Everybody likes computers, except Macintoshes. You hear everybody grumbling at lunch
about how slow their Macintosh is or 'Oh, it crashed again!' I like Windows or Gateways better.” (Kristen, female, grade 9)

Other students reported increasing use of PC computers in their school environments.

“The computers in the classrooms and computer lab are all IBMs. We also have a Mac lab which has 15-20 Macs. These are only used for the keyboarding classes now. In our library, we have several IBMs, and also several Macs used for word processing.” (Kate, female, grade 9)

Rachael lamented that there were six different computer labs at her school, but only one computer in the entire school was networked for Internet use!

“Two of the labs are open to all students and four of the labs are in private classrooms. None of these computers are connected to the Internet. The new newest computers are compatible with Windows, but one of these computers are connected to the Internet. The two classroom labs used for typing classrooms contain really old green screen Macs, which aren’t connected to the Internet either. The Journalism classroom contains only Macs that are about 2-8 years old. One computer is hooked up to a scanner and one computer is hooked up to the Internet. They have no Zip-drives for big documents. The Industrial Ed classroom contains computers that were built (yes, hand built) by students. These computers a year old and are used for PowerPoint Presentations and Architectural Drawings. One computer is hooked up to the Internet and another is hooked up to a scanner. Only one computer—in the whole school—is open to all students for Internet use and this computer is located in the library!!” (Rachael, female, grade 10)

A few students used Macintosh computers both at home at school. Students continued to complain that even if their school computers were Internet networked, they were slow-responding machines.

“I just recently purchased a new i-Mac home computer. (It's blue!) We also have a PowerMac. I'm pretty much surrounded by Macs and Mac-users. My school uses Macs as well. We have two labs with about thirty computers in each lab. They are all linked to the Internet, but they're very slow!! Frequently, problems arise, and you can't even get logged onto the computer.” (Sarah, female, grade 9)

Regardless of prevalence of a Mac or PC in school or at home, boys in this group, were more likely than girls to have a computer in their own bedroom. “I have a computer at home in my own bedroom at home!” Jake announced. So did three other males in the study. Many girls, however, wanted computers in their rooms at home. Melisa asserted, “I don’t have a computer in my bedroom, but I really want to get one though!” “Unfortunately, I don’t
have a computer in my bedroom at home,” sighed Stacia. Alicia stated, “I don’t have one, I
can’t afford it.” Alli shared two reasons she doesn’t have one in her room.

“My parents don’t want me to lock myself in my room and not come out for hours
because I’m on the computer. The other reason is that any computer I got now would
be the one I take to college, and if I get it now I know it will be incredibly obsolete in
the next three years.”

Two females had computers in their bedrooms. Kristen refers to the computer in her room as
“the fossil.” She quips:

“It was top of the line for about two weeks. Yes, it's a '92 IBM PS2 and a piece of
crap. An ad company trying to sell this piece of crap would say, 'Fully equipped
with Windows 3.1 and a few Megabytes of ram. Hell, my company's too damn lazy
to find out how much, but we know it's nowhere near a gig of memory!! BUY IT!!'
Yep, I sure have computer in my room.”

2. Gender stereotypical behaviors exist for bright females in the study whether
they were using computers for intentional or recreational purposes.

Female students, in the study, were more likely to incorporate text and visual images in
multimedia projects, as compared to male use of sound, action images, and Internet hotlinks or
equipment to build their electronic projects. Both males and females observed that boys were
more likely to fool around with the equipment at breaktime. For example, during lunch breaks
the male students frequently played with the technical equipment such as the scanner, digital
cameras, and the projection device. Girls, on the other hand, gathered together in small groups
of several students to continue conversations often about the week’s events such as the resident
hall movie night, Friday night campus life, or the development of their projects. All students,
however, quickly returned to their projects each day with much chatter about the skills they
were learning and the progress of their multimedia projects due on the final day of the course.

Eric summarized that boys are more likely to use scanners for graphics and to use the
Internet for e-mailing questions to people, which he notes, “does work.” He thinks girls are
more likely to ask for help in class.

“I think that boys are more likely to use scanners and the Internet to download project
information. If I’m having problems sometimes I’ll e-mail my problem to the person
who put up the WWW site to see if they can help me. Which does work. And, for a
time I was a part of a group of people on the Internet based on a series of books I
liked....sorta a role playing thing. So, I used e-mail a lot then to talk to people. As for
girls....(pause)... I think they get help.” (Eric B., male, grade 9)

As an illustration, Jackie, one of the females, asked for help from the instructor and lab
assistants countless times. With an interest in becoming a marine biologist, she created a
multimedia program on dolphins, but had multiple crash problems. Lab assistants, who
assisted students daily in her project development, confirmed her frequent requests for help.
One lab assistant remarked,

“She wanted to save sound from a CD and asked, but looked more towards other
students. Her computer kept crashing, but she seemed to take it in stride...to
always let us know when that happened. She switched computers a lot as if it were
the fault of the machine.” (Deb K., lab assistant, ISU graduate assistant)

Denise, an experienced and insightful lab assistant noticed Jackie’s attention-getting behaviors:

“Jackie seemed very 'inquisitive.' She may have been more of an attention getter than
anything. She asked a lot of 'how-to' questions and didn’t seemed satisfied unless
Jason or myself answered them. She could always describe what she wanted to do,
but really didn’t attempt at all times to use some critical thinking skills to come up with
the answer. She would quickly look to Jason or myself to answer it. For example,
(she did a lot of scanning of pictures) in one of the graphics she was using in her stack
she didn’t want a person to show up in the graphic. She didn’t know how she was
going to get that person out of the picture even using a graphics program. I suggested
an approach, she did it and was satisfied although there were other ways to solve this
particular dilemma”. (Denise, lab assistant, ISU associate director of CTLT lab)

In Jackie’s opinion, she just had too many crashes and blamed her problems on the
computer. Although she didn’t try to fix or figure her way out of technical problems, it is
significant that she, at least, did not attribute her frustrating experiences to her lack of know-
how, yet she easily blamed the equipment or instructors. On the contrary, the males rarely
asked for helped, thought they knew more than they did, and tended to work independently
despite the fact that they talked loudly and incessantly during each class period.

Not all gifted females asked for frequent help in class, but others expressed a sense of
marginalization in more complex computer activities. “Guys do a lot more programming and
stuff. Girls check e-mail more,” expressed Alli. Jake had 5 online alias chat names. He
thinks “computer programming is a guy thing.” Guys are expected to do that.” (Jake, male,
grade 9) Kristen has it figured out. "You see a lot of, I don't know-this sounds really sexist and stereotypical, but a lot of people I've met...it's mostly the guys that are talking about how they can make web pages...we're[girls] not." (Kristen, female, grade 9)

Jessica observed that the girls have developed more aesthetically appealing project designs and that guys have more action-oriented project designs. Although she was a bright, articulate female, she was hesitant and tentative as she expressed her views on the difference in the way the males and females in the class created their multimedia projects. She states, "I think some of the projects that we [the girls] have, I'm not saying this to put down guys or anything, but the girls' projects, I actually have found, to me, to be a little bit more appealing. I look to the person next to me and then the other person next to me, and it happens to be the girl's over the guy's. Not because of the subject, I personally, like the guy's subject actually better, but his design on his project and the way he set it up, it just seemed it was all action, pictures, and sound. [There] wasn't much else added to it from him. But on hers, she had maybe one or two pictures imported and the rest were created by her. She added a lot more writing, and was a little bit more interesting." (Jessica, female, grade 9)

Eric, however, was quick to defend lack of aesthetic appeal in his multimedia project design by stating, "In a project like this, you need information so graphics are just a nice addition, but you don't want them to over power everything else. You need action." (Eric B., male, grade 9) Action is associated with use of computers, according to the males in the study.

Similarly, male students were more likely to build action into their multimedia projects and were more likely to report technical information relative to computer memory, speed of processor, or size of hard drive. Girls, on the other hand, more frequently reported computer technology use or function of software. They needed the computer to do what they wanted and needed it to do. Their emphasis was on computer performance, not computer power. Eric, Chris, and Erik (all males) have specific ideas about the technical elements of their computers.

"I would like to use a dvd rom drive, click drive, and 3d graphics card. I'd like web design software like Microsoft Front Page and Adobe Page Maker and a gif animator. I use a dell 200 MHz computer with cd rom, printer, 17" monitor, 33.6 modem and 4 gig hard drive. Any questions feel free to e-mail me." (Chris, male, grade 8)

"At home I have a game demo CD and a brand new Gateway P5-166 XL computer with Windows '98. I've been downloading some sound and movie clips, and emulators (Super Nintendo and Game Boy) with great games." (Eric B., male, grade 9)
“We got a new Gateway then they came out with the 400 MHz chip right after we bought it. We got the 300. We could probably get an overdrive if they make one for it. I’ve got a lot of magazines about increasing the power of the card.” (Erik K., male, grade 9)

Girls, on the other hand, reported useful function of their computers. They associated use of computers with communication and completion of school projects, rather than as powerful machines.

“I learned Adobe Photoshop for the Macintosh and had fun scanning and altering photographs. It helped me with school-related projects, because the program I use now is very similar.” (Alii, female, grade 9)

“We got a new top of the line computer with lots of software at home. It’s great for homework! At school we are still using old Mac's, but we’re using Gateways more. We got some new video editing equipment (a Casablanca system) and are upgrading Adobe PageMill software for the school website.” (Melisa, female, grade 10)

“My parents bought me a computer (P11pro) of my own and I use it every day. I have several games (educational and just for fun) and Corel Word Perfect 8. I’ve got a joystick, speakers, a microphone, etc. Every day when I am on the computer, I play MUDs or research online for homework. I talk to my friends on-line through e-mail, IM, and in the multiplayer games I play. I hope my response is useful to you.” (Liz, female, grade 9)

Liz and several other female students made welcomed transitional comments at the end their responses. Unlike Chris, not one of the females suggested I e-mail them for advice if I had any questions! As Liz and Jessica hoped their responses were “helpful,” Kate offered, “I hope this works for you!” Alli thanked me for her participation in the study by e-mailing, “Thank for lettin’ me be a part of this! I guess I’ll talk to u later.” Alicia brought closure to the study by saying, “I guess that’s my last set of questions. It’s been nice talking to you. Love and luck always.” While there were several females who requested summaries of the research findings, none of the males in the study asked for any summary data explaining conclusive findings of the study. Three of the girls inquired about the results and one has pestered me for information, wondering what can take so long since the study actually started last summer [1998]!
When I asked what students “wished they could do in school using computers,” boys were more likely to request computer programming, computer-assisted design (CAD) courses, or advanced computer courses. Eric B. and Justin had already taken CAD classes at their schools. Eric wanted an advanced CAD class at school using a program called “Design Post Drafting.” He worked with his teacher to get a program to control a lathe, but they are now “working out some bugs.” Eric thinks there should be more programming courses offered. Justin described a course at school called “Global Geography” where students use the computer lab daily for instruction and see “PowerPoint presentations by the teacher and students.” Another male, Chris, thinks the school needs a “gif animator for graphics, as well as updated web design software like Microsoft Front Page and Adobe Page Maker.”

Girls, on the other hand, seemed less aware of possible computer courses or computer-enhanced elective courses at their schools. Furthermore, females took fewer school-offered courses and less frequently discussed computer-related camps and classes. When I asked Kristen if any of her girlfriends were taking computer classes this summer such as Multimedia Mania, she replied matter-of-factly, “Not that I know of. They don’t talk to me about it.” Although Kate remarked that, “In school, I wish we could have more advanced computer classes,” she doubted she would register for computer classes in her 9th grade year.

Nevertheless, each and every student in the study expressed the opinion that females were definitely as capable as males in becoming computer scientists, programmers, or engineers. However, few females believed they would actually major in computer related courses in the future. Similar to the “We can, I can’t” attitude (Collis, 1985) about computers, female students made positive statements regarding general female competence, yet made paradoxical comments regarding application of computers. Their remarks supported the notion that while they regarded females as a equally capable in using computers, they held career goals other than in computer-related fields. For example, Laura stated that “females are as capable as males holding computer jobs, but thought she’d become a historian when she grew up. Stacia
thinks, "Women are capable of anything and everything that guys are...as long as they are properly trained." Stacia wants to work with horses someday. Kate sees both genders as equally capable in using technology, but is thinking of becoming an accountant or an actuary. Sarah, in her commentary on gender issues, sees females as:

"...just as capable, but at the moment maybe not as qualified because the attention has been directed towards males in our society. Therefore, skills lie with the males. That's not to say there aren't females out there who are even more qualified than males. If a study were conducted on all of the computer scientists, the few women in the classes could be better at what they're doing just because they've had to work diligently to get where they are."

As a budding feminist, Kristen says, "This is a time where women are just finishing shaking the bonds from long ago forbidding them to do anything...vote, work, or do anything outside of housework." She referred to slogans like "Girl power" or "Women rule" promoting women having the "upper hand over men for the first time." She inserted, "Pardon my french, but in my opinion, I think equality kicks ass!" Alli confidently admitted she was just as computer literate as her close (and not so close) guy friends. She declared, "If I really wanted to, I could learn anything about computers that I wished. Give me three hours with my friend Mitch and I could probably take your computer apart and put it back together working faster and more efficiently." Because she plans to "become a microbiologist in the United States Army Institute of Infectious Diseases (USAMIID), she does not plan to apply those particular skills in a computer-related career.

Only two of the gifted females in the study, Melisa and Liz, indicated computer-related career interests. Melisa shared, "women are as capable, if not more capable then males because they are generally more patient and calm than men, which can be a major advantage in anything dealing with computers." Liz plans to become a computer programmer, if she can "get the proper education." Of the males in the study, Erik K. wants to build computers, Justin wants to be a computer engineer, Eric B. wants to be a CAD-using architect, Jake wants to be a writer, and Chris doesn't know yet. Finally, Alicia believes regardless of gender or career
goals, "if you set your mind to something and work real hard towards achieving your goal, you can do it no matter what it is."

After spending time responding to follow-up research questions for the purpose of this study, respondents were awarded a $20 stipend. Interestingly, girls were more likely to spend their money on non-technical purchases. Kristen said she'd spend her money on books or food. Alli might spend it on her new dog, save it, put it toward a new dress, or buy her Dad’s birthday present. Alicia would save it to pay for a summer camp in New Jersey. Rachael wanted to buy a Mother’s Day present and Kate will save it for a car. However, Liz will buy a new cd (“You can’t have too many CD’s”), Eric will buy software, Jake will spend it on RPG’s (role-playing computer games), and Justin would purchase a dvd.

3. **Females in the study valued rich experiences using computer technologies in ways that were personally meaningful over time and were positively influenced by interaction with computer-using peers.**

Females who displayed greater levels of self-confidence using computer technology, had more experience using technology and associated with technology-using peers. They reported more interaction in active learning environments playing games, using computer software, or visiting Internet sites. Experience for females does make a difference. As Alicia simply said, “It makes a difference for females, to have experience with technology.” In agreement, Sarah assessed that she learned a whole new way of presenting material and got to know many people during the Multimedia Mania class. She thought the instructor and guest speakers were great. She thought, “just learning all day was so cool! If you are really intellectual and say you are taking a class at Iowa State—everybody’s impressed!” Girls seem to take fewer opportunities than the males, however, to impress others with computer experience or technical expertise, as the males were inclined to do. Females engaged in computing experiences because they “were important to them.” Examples of important experiences included online communication and computer game-playing, most often outside of
the context of school. Alli mainly used AOL Instant Messenger, did research at home, and sometimes just surfed the 'Net. She associated with peers who had homepages. She said, “Mostly when I'm not on the 'Net to check my mail, I'm diggin’ one of my buds' web sites. Lots of my friends have homepages and update them regularly.” Liz, Mary, and Julie liked computer games. Liz “played text-based multi player games like most of her guy friends do.” She said it is “nothing really out of ordinary.” What Liz may not realize is that it is not “ordinary” for most females to play multi-player computer games, which is why she associates with males who do. Mary talked to her girlfriends online and liked games such as “Millie's Math House and Bailey's Book House for her younger siblings and Independence War” for herself. Finally, Julie liked using computer games such as “Star Trek starship creator and Cydonia, an alien language.” For her birthday she got Cakewalk Home Studio 7 to write music. She states, “I love the music program so much I haven't had a chance to try my ‘Learn to Speak Spanish.’ I've also tried my brother's Star Wars Droidworks to build robots and put them through missions.” She used the program SciPlus, a problem solving science program.

Rachael, a particularly computer-savvy female, took a “Surf the ‘Net” class at Clark College, near her Midwest high school. “I learned HTML and Hyperstudio.” She took a CAD and Communications class to create a presentation about her school's history which “took months of research.” When her principal saw her presentation, she was asked to design the history section of the school's webpage. She explains,

“I am using Microsoft Front Page software. Even thought the program claims you don't have to know HTML, I am writing most of the webpage out in HTML because I hate wizards. This program has taken a lot of figuring out.”

She took pride in “figuring out” HTML during the college class. Expressed as meaningful computer-related experiences, these young women engaged in activities outside of the context of their school environments. Alli “digs her friend’s Websites” at home as Liz interacted in out-of-school multiplayer role-playing games. Mary liked games for her younger siblings, while Julie learned “alien languages” and composed music.
In addition to using computers in active learning environments in association with computer-using peers, females who held perceptions of competence using multimedia-enhanced computer technology during the Multimedia Mania course, tended to select independent topics related to science, sports, or controversial issues. For example, Alli loved science and plans to “work at the United States Army Medical Institute of Infectious Diseases (USAMIID) with viruses, especially Ebola.” Other science-related project topics included Dolphins, Mars, Constellations, and Neonatology. Sports-related topics were about Cardinal Baseball and Chicago Bulls Basketball teams. Examples of a controversial issues were unfair stereotypes of wolves and online computer game activities such as Gemstone3 which involved “disposing of characters.” During the out-of-school summer class, some girls used multimedia as an opportunity to voice their opinions.

“My project is about wolves. I picked this topic because I have an interest in making an informational, persuasive program for people who don’t know much about wolves. I imported a video clip where a person dragged a wolf into the back of a truck and killed it. I am just saying, “Don’t let this happen again.” (Sarah, grade 9)

None of the male participants had topics related to science, sports, or issues, however. Instead, they selected subject matter such as dragons, the Simpson’s, Vincent Price, Jimi Hendrix, and the history of Boy Scouts of America.

4. Gifted adolescent students insisted there were no gender differences in male-female use of computer technology among their teachers, peers, or parents. However, their interview narratives provided interesting evidence to the contrary.

Teachers: Students reported limited use of computers by their classroom teachers in general. Most students observed their teachers mainly used computers for typing up class notes and tests, letters they wanted to send home for parents, grades, and e-mail communication. When first asked about gender differences in their teachers, they were quite certain there were none. After asking them to think back about what specific teachers had
accomplished using computers, their descriptions revealed gender differences. Subsequently, they recalled conventional uses such as word-processing and grading management by females in English, library and social science courses with more sophisticated uses from male teachers in science and math curricula with the exception of females teachers in those content areas.

"My female teachers use their computers mostly to type up and enter grades, print up overheads and worksheets, and occasionally check e-mail accounts when we are working on something." (Kristen, female, grade 9)

Jackie remarked that her Spanish teacher, English teacher, and cultural geography teachers [all females] use the computer for grades and attendance, but she says, "My computer teacher [male] uses the computer to actually teach the class." Alli had three female teachers in high school. Her Citizenship teacher, used the computer for word-processing, study guides, tests, and grades. Ms. B, her Spanish II teacher, used the computer for grades and QuickMail. "She may use it for other things but that's what I see her using it for." On the other hand, Mrs. B, her Algebra II teacher, used the computer for mathematics problems in a more interesting way. "She hooked it [the computer] up to the TV and uses some program that is like a really advanced graphing calculator." The female Algebra teacher, using computers in a more advanced, interactive way, most likely introduced a graphing program such as Geometer SketchPad®. Female teachers, who used computers in more advanced ways, seemed to teach subjects such as mathematics or science.

"Most female teachers in my school," replied Mary, "use computers to type progress reports. My geography teacher, Ms. Jones, gave us time during class to use the National Geographic CD-ROMs to look up information on a country." Her computer teacher, a female, taught students to use PowerPoint. Julie's female teachers in "chorus, journalism, mathematics, Spanish, language arts/social studies used the computer for grades and word-processing." Her mathematics teacher [male] uses it for "fooling around" and her computer-lab teacher [male] uses it for "teaching multimedia and the Internet." Similarly, Kate says, "female
teachers in my school basically use computers for grades, word-processing, typing up worksheets and tests, etc.” Liz observed ways her female teachers use computers:

“Most of my female teachers use computers somehow in their job. My fine arts teacher, Mrs. J., uses the classroom’s Gateway Destination every day to present vocabulary to the class. She prints out worksheets, overheads, and tests off her computer at home and my Spanish III teacher (Mrs. B.) prints out worksheets, overheads, tests, and grade up-dates. My English 9 Accelerated teacher, Mrs. B., doesn’t use her computer for anything that I know of, but she lets the students use it for presentations when we need it.”

Another student, Sarah, reported that her geometry teacher, Mrs. B, used a spreadsheet to print off grades using numbers to represent their names, so kids can “check how we’re doing in class about once every two weeks.” They’ve never used “that software program to design geometric figures,” but Sarah had “heard they might be able to in the future.” Her female Spanish teacher used computerized test review use about once a month and her World Studies teacher, Mrs. G., took students to the Media Center for about three days of research per semester on the Internet.” My English teacher, Ms. B., used the computer to print out notes on a transparency, reading evaluation sheets, or written assignments.”

With the exception of searching on a CD or the Internet or, perhaps, designing a PowerPoint presentation, students perceived that few female teachers modeled uses of computers to develop or enhance problem solving or higher level thinking of students. It does not require much reasoning skill for students to locate their name by number on a spreadsheet of posted grades. It is a key concept then, that students are not observing many female role models using computers in sophisticated or complex ways.

In sixth grade, Kelsey had both a female and a male teacher. The male “used the computer more to present information, do research, and get stuff off the Internet.” Her seventh grade science teacher did a ‘Save Our Streams’ project where students e-mailed another class about their state and water shed. They posted information on the Internet. However, as with other students, she said her computer-savvy science teacher was a female. Similarly her female “language arts teacher did not use the Internet, like the female science teacher did.”
Students reported that male teachers were not only inclined to use computer technology more often, but in more engaging ways. "My Biology teacher, Mr. M., uses his computer every day in class. He keeps an up-to-date record of our grades in Excel." Her electronics teacher, Mr. P., "although he rarely remembers spellcheck," used his computer for worksheets, overheads, notes, and tests. "My choir teacher, Mr. S., used his computer to keep track of money in our accounts for a trip to Colorado and to chart fund-raiser money." Kate observed that male teachers in her school used computers differently than females. She says male teachers often "play games on them and surf the Internet when a class discussion is over with." One of her male teacher "plays games, surfs the 'Net for sports sites, and enters statistics from the game the night before."

However, as with most of the group members, Kelsey is convinced that computer use of male teachers "isn't much different than that of females." She observed that her [male] science teacher, like her female teachers, prepared grades on computer printouts. Yet she added, "I see him playing games on the computer. My Social Studies teacher [male] looks up lots of basketball statistics on the Internet." However, when asked, she could not think of a time when any female teachers either played games on the Internet or looked up sports statistics.

Alli currently had three male teachers in her schedule. Her Ancient World Civilizations and Humanities teacher, used the computer for word-processing tests and for recording grades, but Mr. F., the Elements of Chemistry and Physics teacher, used the computer for word processing tests, preparing class handouts, and recording grades. He also used it to give presentations and to scan pictures for lectures. Mr. V., her Combined Advanced English 10 and Speech teacher, used the computer for many class handouts, tests, answer sheets, and grades. While these were conventional uses of the computer, she remarked that Mr. S, "one of my more technically inclined teachers, who also teaches a computer engineering course, used
computers to give presentations and for Internet research.” Alicia, too, thinks “guy teachers used computers more for class time while females used it for tests, but not so much in class.”

Melisa puts it bluntly, “With regard to just skills and interests, it’s male dominated. It’s the male teachers who have the skills.” Chris adds that it’s not just the skills and interest, it’s the “conversations held between teachers,” that mirrors communication of their students.

“You don’t hear them [female teachers] talking about computers and stuff, but since Mr. X [a male] is actually teaching about the computers, you hear him talking about what he knows. My computer media teacher is a guy and he knows a lot about computers.”

In contrast, Sarah’s only male teacher is Mr. “Giant-Baldus,” an earth science teacher who doesn’t like the computer at all. “He used it to print out little sheets of paper that informed us of what we’ll be doing each day, but he tells us he’s never going to let the computer ‘overtake’ him.” This teacher, on the other hand, has created a home page where the students can enter their special number and get their grade. They can find out about what they did in class that day. Therefore, even if students perceived his disinterest in using the computer for earth science, it is definitely not because he lacked technical skills.

Peers: Just as students tried to minimize gender differences between male and female teacher use of computers, they were actually unaware of gender difference with peers until they talked aloud in order to describe what they see males and female peers doing in general. Even then, several were adamant that there weren’t differences in computer use of male and female peers. Eric sees students as “mostly the same in finding information using the computer.” Yet they differ in the topics they investigate. “You know, girls some go in there [the Internet] and they look up stuff they are interested in and guys go in there [the Internet] to look up cars and sports and stuff.” He could not specify “what” girls were interested in finding on the Internet. Melissa says, “Using e-mail is the same for both sexes...the same sad puns and stuff. And basically, you use it the same way. Like one time you’ll get this really sensitive stuff that makes you really depressed.” As she thought about it more, she said, “I think guys use it [the
computer] more for fantasy games like, Dungeons and Dragons or Raiders of the Lost Ark, Girls don’t.” Jake, had an interesting observation after assuring the group there was no difference in how males and females used the computer.

“I really don’t think there’s a difference in male and female use of computers. It’s an information thing. Everybody will go to the Internet and type in the same kind of words.”

Later, however, Jake mentioned that there is a difference in “how people use computers.” In his estimation, guys use Internet chat rooms differently than girls “because half the girls in the chat rooms are really guys.” Perhaps he is speaking from personal experience, in that Jake had 5 e-mail account names. He regularly communicated using all 5 names. None of the females reported having multiple alias online names for communication.

However, Alicia noticed gender differences in her school. “In my school, I think girls use computers more for projects, like getting school work done, and guys go on there [the Internet] just to fool around. They tell their teacher they are going to work on their project, but they go on the Internet and just look for stuff that’s personal.” Liz thinks most girls tend to chat a lot online while guys download MIDIs like Star Wars things. “Games are more male-dominant,” she says. However, Liz is heavily invested in an online game, Gemstone3, which she thought should be equally interesting to girls, but the “girls haven’t discovered it, because guys tend to be more computer literate.”

Chris, an insightful and observant male, assured the group that he used to “see lots of guys and not many girls using computers, but I see it’s equal now.” He assessed that “normally the skill levels are equal now, too.” However, he noticed the guys in his TAG class at school knew lots about computers and are always on the Internet. “I’m always talking to them on Instant Messenger, but, you never really hear the girls talking much about IM. But they do use it, they say. But it’s just not a part of their social conversation.”

Jackie didn’t notice that girls interacted less in conversation about computers, but she noticed that girls tend to talk to their computers more than guys. “I’m serious, I really am.
I've noticed that with people sitting around me, I only hear girls talking to computers. Most guys don't generally talk to their computers." Eric disagreed with his usual humor, "I've given a cuss word, but nothing other than that." Then Jake added laughing, "I've threatened it [the computer] a couple of times."

On the topic of threat, students talked about violence using either computer games. "Most of the games that people play on the Internet are more violent-centered," Jackie offered, although she talked very little about playing any computer games herself. Rachael, though, recalled a specific game. "There's this one temple game or something, where the character is this female who is half naked running through the jungle." Then Eric summarized seriously and poignantly, "In a lot of the games there's (sic) two types of women. The ones who are supposed to appeal to the males or the ones that die." Most of the males, yet few of the females, had interacted with computer games where women are either sexual images or dead.

Some females think guys are expected to better at using computers (Kate, Mary, Stacia). "Girls can do it, but they've [guys] just had more practice." Females perceive that males are more confident. Kate states,

"Well, they [guys] think they know everything. They think they automatically are going to be good at it, so then they have more confidence. I have worked with computers a lot. We used to have Macs and now we have IBMs, so I have worked with a lot of different types."

In one focus group, students reached consensus that guys who are "big computer users are nerds," but computer-using "girls are really big nerds." One dissenting opinion was Jackie, who said in her school, "computer-using girls just don't get paid attention to in our school. Nobody cares if girls use computers or not, but the guys are just kind of in this little group." Either being classified as a "really big nerd," or being "ignored" will not inspire females to use computers.

**Parents:** Gender differences exist in parent's use of computers. Student comments about their parents revealed that persisting stereotypes in the classroom or with peers, are
displayed at home. Students observed that fathers used computers for work and mothers seemed to use computers for communication. As before, students began the discussion by insisting there were no appreciable differences in parental use of computer technology. Alli, initially disagreeing with “all that male dominant bull crap that we have going on in our society,” said in the very next sentence, “If something goes wrong I go, ‘Daddy’ and he comes and fixes it.” Mary feels “bad for those computer fix-it guys. My dad doesn’t like to fix computers.” Kristen, laughing hysterically at this point said, “Our computer got hit by lightening once and he [Dad] was hell bent on fixing it himself. It was funny to watch him.”

As students reflected on their parents’ purposes in using computers, Liz thinks men go on-line to look for information for things, like “tools and mechanical stuff.” She clarified this stereotyped image by saying, “I am not insinuating that just males use tools, but that’s more of what they do.” And women, she added, “go on-line and to look for recipes, usually. I don’t mean to discriminate against anybody. I’m sure males do [look for recipes], too and women look for tools and mechanical stuff.”

Laura noticed her dad used the computer more for work, and because her mom didn’t work, she was just learning how to use the Internet. “But she’s catching on really quick.” Kate saw her mother as cautious. “She thinks that everything we are doing is, like, going to crash the whole computer.” Her dad is “more ready to try stuff.” Alli and Jessica’s mothers use the computer more for communication such as e-mail and QuickMail, while Jessica’s dad “won’t use it for leisure time, but does taxes and other business stuff on the computer.” As a teacher, Stacia’s mother uses the computer for organization of notes and papers, a behavior Stacia is quite likely to see in most of her female-instructed classes at school. Kristen’s parents portray another stereotypical pair:

“He [dad] does a lot of taxes on the computer. He does a lot of stuff like, Quick Time, Excel, and databases. He writes his resumes on Word Perfect and I’ve seen him play a lot of games and he goes on-line a lot. She [mom] used to be a secretary and she was freaking out that she had to use Word to type up the minutes. She’s like, “What do I do here? How do I do this?” And so we finally convinced her to get an AOL name, but she’s never gone on.”
5. While bright adolescents in this study found some educational computing school experiences relevant, most reported that they were largely self-taught and that their classroom teachers lacked necessary computer skills.

At first students rolled their eyes and complained that school computer-related experiences were either unchallenging or trivial. Yet as they began talking, students shared more relevant school technology experiences. These experiences were described as meaningful to the students and seemingly connected to their school curriculum. For example, in 8th grade, Kate described available computer classes as Keyboarding, Computer History, and Computer Business Applications. Despite the fact that the classes were “outdated, and taken in a Mac lab, with computers that are 10-12 years old,” she defended the classes as necessary because some of her classmates don’t have computers at home. “This is the only opportunity they get here at school.” She would like to see a class with digital cameras, Hyperstudio, and use of scanning—all skills she learned outside of class during the Multimedia Mania summer course.

Eric, who has already taking a high school Computer-Assisted Design class, took an Internet computer class using Hyperstudio® to create two projects. One was required to be a project about his school. He used “digital cameras, scanners, and everything” during class. “We used ClarisWorks, Hyperstudio with recordings, microphones, and graphics. We used the Internet, but we haven’t used databases and spreadsheets other than in that class.” In another computer-related course experience, Jake shared that he has “somehow managed to land in three different computer courses” in high school. He used computers in “Computer Tech class, Computer Graphics, and creating the School Annual.” He defined Computer Tech as “a class in designing programs...like Hyperstudio.” He further elaborated that he “was not doing Hyperstudio, but designing programs like Hyperstudio.”

Kate shared effective use of communication technology. She used the Iowa Communications Network (ICN) with 50 other Iowa schools in her physical science class to interact with an astronaut from Iowa. “We had the opportunity for a question and answer
session.” Several students “took advanced classes over the [CN],” she added. In addition, they used the ICN for a Careers Exploration class. She “talked with a Department of Natural Resources Worker.” Another engaging use of technology was during her computer Holocaust unit in English. “We did time lines on the computer using word-processing and made newspapers pretending that we were reporters during the Holocaust.”

Sarah’s teachers used software in interesting ways. Her seventh grade mathematics teacher used a computer program about tangent and angles. “It was a flight flier and you aimed the plane at the target to find the tangent of the angle and so forth.” Her Industrial Technology (ITEC) teacher had students record woodworking materials to track expenses for making a product. “We recorded that [data] on a database and it did the math for you. As you typed in the numbers, it would give you the profit or the cost of the item.” Her mathematics teacher and ITEC teachers were both male. So was Kate’s English teacher.

Whether school experiences were perceived as adequate or not, students gained skills by self-instruction outside of the classroom. Chris had taken astronomy, chemistry, and radio personality at College for Kids, a summer offering for gifted students. His computer skills “do not come from books or manuals.” He just “got into the programs and just used them.” He taught himself how to use most programs. Jake learned most of his computer skills from the Internet. “I learned how to write HTML. I learned it all myself on an Internet course.” Liz just “figured out Excel little by little at home with a little help from dad, mom, or friends from school.” She took an HTML course as a non-credit course at a local community college. “I’ve always been interested in programming and I wanted to make my own web page...to do the code myself and not have to use a program.”

“Messing around” is a way for students to learn. “I learned skills when I was messing around with the computer,” Mary analyzed. Jackie learned about the Internet with her dad and friends. Melisa learned technology skills with recently upgraded Gateways at her school where her dad is a teacher. “I just go in after school and mess around on his computer.” Rachael,
who found she liked challenging work on the computers, was quite troubled by teachers who “stand up and lecture on what you are going to do and how to do it, and then make you go do it.” She preferred independent work. Alli is self-taught with a help from a parent and her peer group. “Basically, you learn to teach yourself...my friends taught me some of the stuff and my dad helped me a little bit.” Jessica assesses her ability to learn computer skills by smiling and saying, “I am one of those people who can figure out things just by looking at it, so I did most of it by myself.” Along with “messing around” and completing self-instruction outside of school, is a sense of self-efficacy embraced by males like Justin, “I have just been doing computers all my life.” More males than females, however, seemed to hold a “We Can, I Can” view about using computers.

Classroom Teachers: That students perceived their “classroom teachers as lacking in computer skills” was an understatement. They not only viewed their teachers as lacking computer competence acquiring and using skills in curriculum experiences, they see teachers as weak facilitators of student use of technology. Comments were rapid and resolute. They couldn’t say enough about the need for teacher training in technology.

“Nobody [our teachers] uses technology in our school. They’re clueless. I mean, they just got the new computers and there are like two people that know how to get on.” (Melisa, female, grade 10)

“More training? YES!!!!!!! SOOOO (emphasis hers) many of my teachers, past and present, have had no idea how to use their computers!!!! They learn how to do grades and QuickMail but then request the students help for anything else!!! Teachers NEED to be more prepared for our technologically advancing world...especially those that have problems turning on the machine!!!” (Alli, female, grade 9)

Students see themselves as guiding teachers through uses of the computer and are impatient about wanting to learn at a rapid pace so they can “figure it out on their own.”

“Some teachers need more training. It’s somewhat pathetic when a student must guide a teacher through using a program that has been on their computer. If something is placed on a computer to enhance the teacher’s organizational or teaching skills, they should know how to use it.” (Liz B., female, grade 9)

“I took an Industrial Tech. Class, but I didn’t learn very much from her, because she didn’t really know very much about it herself. There was just a manual that somebody else wrote and she wouldn’t let us figure it out on our own.” (Justin, male, grade 10)
Not only do students think teachers underestimate student level of skillfulness, they think that teachers have trouble incorporating technology into the classroom curriculum.

“Well, I would like to say that I got my skills from school, but I really didn’t. Because our teacher underestimates our abilities and treats us as if we have never heard what a computer was until we got to his class. He’s like, ‘This is the mouse.’ He doesn’t teach us much. He goes over stuff that all of us already know.” (Jake, male, grade 9)

“We got to use the digital cameras to take pictures of each other to put on our Holocaust presentations. The cameras were not widely used in my school, partly because I don’t think the teachers know exactly how to use them or incorporate using them into classroom curriculum. For English and Math, they [teachers] didn’t know how to incorporate Hyperstudio into the things we were doing.” (Kate, female, grade 9)

Kate reiterates a salient point, that not only do teachers not know how to use technology, they do not conceive of ways to integrate it into their curriculum. Kristen agrees teachers need help.

“I think teachers need more training. A lot of my teachers complain they can’t get the grades done because they don’t know how to load/run new software, there’s something wrong, etc. Some of my teachers don’t know how to run half the programs already on their computer!” (Kristen P., female, grade 9)

Even with trained teachers, computers are not necessarily used in complex ways. Sometimes because teachers need support and sometimes because they reject the novelty of computer use.

“Our teachers have been educated on using M-power but I was the only one other than the teacher that knew how to use it, I helped my classmates with the project.” (Alicia R., female, grade 9)

“My teacher is an older lady and not inclined not to use them [computers] because she is always uncomfortable with them. I think she knows how to use them, she just doesn’t like to. I have never seen her ask a guy or a girl for help with the computers. She has never really asked for help.” (Jackie, female, grade 9)

Finally, for some students like Mary and Sarah, lack of teacher training using technology means they lose valuable learning time.

“I think teachers need more training because very few teachers at my school know how to use even simple programs. They have to go and ask another teacher how to use the program and, if that teacher doesn’t know how either, continue to look until they find someone who understands. If they had more training, they would be able to teach us more things.” (Mary G., female, grade 8)
"Some teachers, like my science teacher, have had training and exposure, but just because it's different, they don't like it. No one likes change, so some teachers might not be willing to have the training. I do think, however, that teachers should be required to have some instruction on computers, if anything for their student's sake. What if I have a question....I'll lose a lot of valuable time on school work because my teacher doesn't know anything about computers." (Sarah B., female, grade 9)

6. Gifted students in the study were generally impatient with problem solving instruction. Individuals who valued problem solving seemed to hold greater capacity for developing complex ideas using computer technology as a tool. Gifted students generally resisted problem solving instruction in relation to building multimedia-enhanced projects during the Multimedia Mania summer course instruction. They were introduced to an information literacy curriculum, an information problem solving process, and a set of skills that provided strategies for efficiently and effectively meeting information needs in academic or personal decision-making tasks (Eisenberg & Johnson, 1996). In order to enhance problem solving using technology, each day students learned sequential steps of task-definition, information seeking strategies, use and synthesis of information, and evaluation of the process. Laura bluntly stated problem solving was "too much work to try to relearn what we have been taught since first grade." Kristen complained that problem solving instruction was "so freakin' boring!" She continued, "I believe this generation is a hands-on generation. I took this [computer course] to get away from the normal classroom setting and have 99.9% hands on. Instead, I got to re-re-re-re-re learn the steps of problem solving." Alli thought "actually stopping to think about steps in a problem made it more confusing than if we had just been given the problem and been allowed to solve it in our own way." She saw it as a "HUGE waste of time." Instruction disrupted Rachael's flow of thoughts. "When I am problem solving, my thoughts come so swiftly that the process of analyzing my thoughts and placing them into neat little categories disrupts my flow of ideas and makes it harder for me to problem-solve." Jake said, "The problem solving part of EXPLORATIONS! hindered our actual project, slowed us down." Rachael did not think learning these skills was useful.
"The Big 6 seemed...well, I guess to put it bluntly, kind of like a lot of bull to me because... Well, how you have to write everything out, and with all of the other different things that we have learned at school and stuff and writing stuff down, I just don't see the use of the Big 6." (Rachael, female, grade 10)

Justin "just wanted to get going on the project because I wanted to see what I could do." He added, "I don't like to write about how I am going to do it." He preferred doing the electronic project and then determining if it worked. Similarly, Kristen did not like interruptions and wanted to explore. She thinks of problem solving as getting out of "a jam."

"Isn't that what life is about? It's exploring. And the Big 6... we all use it, but we do it subconsciously, then why do we have to write about it? I think we can solve problems quicker subconsciously than having to actually think about it. I think of problem solving as when I am in a jam." (Kristen, female, grade 9)

Jackie "solves problems in her head and doesn't need to write steps on paper," because she can "remember what she was doing." While she says she doesn't actually think through steps, she quickly articulated her information-gathering techniques, yet did not see these as strategies for problem solving.

"Okay, I have to think through the problem." When we had to pick our problem for this electronic project, I was reading the book, The Dolphins of Pern, by Ann McCarthy. That's where I kind of got my idea and my inspiration for my project. I thought, okay, this is going to be my problem. (before I got the worksheet on it.) I went to the library that night and I checked out three books on dolphins and I got information from them. I found information on the Internet, I saved it, and wrote notes, and brought it all here."

Not all students, however, complained about the problem solving strategy instruction using the Big Six (1996). Those who expressed greater tolerance for metacognitive thought about their work or problem solving instruction produced electronic projects with greater depth, quality, or complexity according to the final evaluations of their Multimedia Mania (MM) projects (see Appendix Table 2). Kate and Sarah, who scored the highest in the class, had introspective comments about learning problem solving skills:

"I like learning about the problem solving process. It was helpful in locating sources and processing information. It made me think about my audience. I chose to present my project on a program I had never heard of, m-POWER®. This is similar to Hyperstudio®. I learned how to connect cards using 'hot buttons,' how to integrate short movie clips into my program from a video, download a graphic (which I turned into a background), and how to connect a slide on my m-POWER project to a site on
the Internet. I learned so much about identifying the steps in problem solving. It was hard to understand at first, but what a help it was, once I got the hang of it! I also learned to scan in pictures and use a digital camera. I feel I could use the computer better now, and catch on to other programs more efficiently and quickly because of the experience. This class stimulated me to learn more about the computer, in general!”

(Sarah, female, grade 9-multimedia X score of 94)

Sarah, commented on what she had learned about the problem solving process.

“It’s task definition, location and access, source seeking strategies, use of information, then you have synthesis and evaluation. And first you have to define your task so know what your problem is, or what you are, perhaps, researching. Like mine would be wolves. I’ll just use mine for an example. Then I think of what I could use. I could use the Internet, I could call people, I could write letters, I could look at books, movies, the Internet. Then I decide what I am going to use and I locate my sources. I dig for information and write down the sources. With use of information—I have to read through all my information that I gathered from the sources and decide what I need to use from that. Then I can choose what to put into my project or what to discard. Oh yeah, and then synthesis, I decide what categories I am going to put it in. In my project I separated information into six categories. That’s just organizing and collecting your thoughts. Evaluation is when you proofread it, go through it, and look at the rubric that we have.” (Sarah, female, grade 9)

Kate had similar sentiments that problem solving steps during the course were useful:

“Well, the Big 6 helps because you have somewhere to start. It’s not just like you actually jump into it. You have steps to go through and you can see where you’re at and how far you have to go before you are finished. I started my Hyperstudio® on the Chicago Bulls at home before we came by looking for stuff. I went in order [using the problem solving steps] without actually knowing it. It helps to like identify the steps.”

(Kate, female, grade 9-Multimedia project X score of 94)

Kate thought this was hard and boring for some students because “we don’t use problem solving strategies on a regular basis.” Chris, who scored high among the males, reflected that he might use technology more knowledgeably now that he had “actually gone through the whole thing and knew all the steps.” He thought it seemed like a pretty good strategy...“first defining it and then researching it and stuff. It’s what you normally do, but you don’t think about it, but it might help thinking about it now.” (Chris, male, grade 8-multimedia X score of 91 )

In retrospect, some students admitted learning from the problem solving instructional process. For instance, Eric B. (multimedia X score of 84) reflected,
"I finally learned the difference between a report and a research project. 'Cause in a report you kind of look at all your research but then you write what you've learned. But, in research quote stuff word for word and you have to have many sources. It gets really frustrating sometimes trying to find all this stuff."

Stacia (multimedia $X$ score of 89) thought the organization part “helped a lot.” She mentioned a software program, “Inspiration®, that little branching-off thing, really helped. I think that was cool.” Liz, who was very computer-literate, but not particularly committed to finishing her project, generalized that the computer helped her “solve problems by keeping her organized” and “find information needed to solve my problems.” But she thought it depended on what kind of problem she was trying to solve in order to go into deeper detail.”

In summary, Sarah explained that problem solving instruction might transfer to other content areas because,

“It helped me recognize what steps I go through. When I problem-solve, I look at the problem and try to solve it. And I hadn't really identified the steps of locating the sources and processing the information. I had never run into something like that. So I figure it is helpful across disciplines. It's so weird how it affects everything.”

Kate observed that the multimedia class helped “in messing around with the computer, trying to fix errors and problems.” She resolutely stated, “I will take those skills with me.” She became more savvy about the computer “fix-it business.” She liked it when students responded to one another’s questions. If students had a question, she noticed, someone [another student] would “come right over to you to mess around with it [the computer].” She paused, “then your last resort would be to ask [the adult in the computer lab].”

Just as students reported varying ways that computer technology was a tool to help them with problem solving, they saw the computer as a problem needing to be solved! Mary humorously acknowledged:

“The computer is a tool for problem solving because when something doesn't work you go through the problem solving steps to try to fix it. For example, when my printer didn't work, I tried to fix it myself by finding out what the problem was. When I was unable to locate the problem, I called the company and am now able to use the steps they told me to find the problem and fix it. By calling the company I used problem solving skills I would not have needed if I didn't have a computer!”

Melisa quips that the Macintosh computers are the problem!
“Computers help with problem solving because you have to figure out how to fix problems to make things work right. Macs are GREAT for teaching problem solving because they give you errors every two minutes. All it says is ‘error type 2.’ If that doesn’t teach problem solving what does?”

Kate and Liz viewed computers as resources with endless applications to help them prepare and edit reports, to lay out tables, or to organize information using Excel. Alli thought computers helped her use the Internet as a research tool and made things look neat because “it’s uniform.” Alicia added that the Internet helped her “e-mail an expert on a topic to help solve the problem of finding information.” Stacia maintained that regardless of the computer or Internet access, “our brains are the biggest problem solving tool, but the computers help us organize our thoughts!”

Jake and Sarah understand that using the computer in one way helps them with a subsequent application. Jake likes to “breeze through” his projects, however.

“If someone has a problem in their project, they need to know how to get through that, so they can breeze right on through. Technology—not only gets them out of a jam, but it usually incorporates a way for you to learn how to do that again next time.” (Jake K., male, grade 9- multimedia X score of 69)

Sarah shared an example of her use of the computer as a tool for problem solving an e-mail communication problem.

“The computer presents, as we all know by now, many of its own problems. In fact, just trying to get into Hotmail was a problem that needed to be solved. I tried different ways of logging in, restarted Netscape, tried composing an e-mail to get in, and at last, right before I gave up, I waited a minute longer after logging in, and PRESTO! my e-mail list came up. The computer challenges you and makes you retrace steps, figure out what you did wrong, yet provides ways for you to fix your mistakes. The more you use computer technology, then you sort of think, Oh yeah, I used that in the last program, so maybe I can apply it to this one. And you just keep growing.”

Indeed, adolescent students using the computer “keeps on growing.” They seem to create a culture of computer use for communication, goal-setting, and future career plans.

7. Adolescents in this study interact in a computer-culture of their own definition outside of the world of adults and perceive application of computer skills to their future career goals.
The culture of computer-using adolescents included abbreviated language and cryptic symbols, known as "emoticons," that punctuated their digital communication style. While varying in use and frequency, females used more symbols than males in their e-mail communication. In fact, none of the males in this study used keyboard abbreviations, but many females did. Examples used by females (especially Alli) in their e-mail messages included common phrases such as:

- TTFN stands for Ta-Ta-For-Now (Tigger from "Pooh Bear" used to say it)
- TTYL means Talk To You Later!
- NM Never Mind
- G2G Got to Go
- GTG Got To Go
- ROFL Rolling On the Floor Laughing
- ROFLMAO Rolling On the Floor Laughing My @$% Off
- BRB Be Right Back
- BBL Be Back Later
- AFK- "when you are chatting, means Away From Keyboard...basically means you’re probably still on the computer but don’t want you to IM them at the time."

Other than that, a number of e-mail messages contained "smilie" faces of many variations:

- :-) Standard Smile
- :) Standard Shortened
- ;-) or ;) Winking
- >:) Devilish
- :( or :( Sad
- =) Second Standard Smile
- 8^) Sunglasses and Carrot Nose
- =~) Gotee wearer (can go on any one)
- 0=) Angel
- =) Devil
- :P Sticking Tongue Out
- <=) Conehead

There are a ton of faces, but on IM :-)) looks "kinda kewl," and so does :^)

- #:-) funky hair
- {:-) more funky hair
- :-P tongue sticking out

^-^ Is an animal face!!!

^._^ Means the animal character ate a lemon!

Other symbols created graphics such as a Simpson icon, a rose, a heart, and a frog.

@@@@@@@=) stands for Marge Simpson
Adolescents interact in a computer-culture of their own definition. Their parents were not necessarily aware of nor were they privileged to e-mail or involved in Internet activity of their kids. Alli said her dad would “kill me if he knew I was still e-mailing that guy from New Jersey.” Laura agreed by stating, “My mom is paranoid about my use of the Internet, and she doesn’t want me going into chat rooms. I have my own [e-mail] address, but she doesn’t know that I do, so that’s fine.” Mary, too, said her “mom doesn’t want her to go into chat rooms or give out my address.” Stacia doesn’t have e-mail at home, but uses her friend’s when she goes there. “That’s the first thing we do is get on the Internet and chat and stuff.” Kate flatly remarked that her dad “doesn’t have any input with what I do on the computer.” Alli’s dad leaves for work at 6:30 am, so she has her home all to herself. “It’s just me and my sister, and she doesn’t really care. My mom is either on the phone for business or she’s at work. I am by myself and I don’t think anyone really knows.” Alicia’s dad “doesn’t really know what goes on.”

Kristen said her dad installed Internet blocks for her protection from objectionable material. “I used to get a lot of this really sick mail and invitations to porno web sites. My dad showed me how to put a block on my e-mail and I’m really happy.” Liz agreed, by saying she’d done the same thing. Liz, however, probably figured out how to install the block by herself. While several students commented on avoiding objectionable Internet material, others talked about distributing “weird stuff on the Internet.” Jake, who e-mailed me [April 1999] asking if I knew about “ISU summer courses on the Japanese language” at my university. He
smugly shared, “Well yeah, I started my own samurai clan, signed on to Red Dwarf fan club, and began a religion, stuff like that.”

Students wanted communication privacy. Kate was adamant. “My parents read my e-mail and it drives me nuts!! That’s why I got my own [account name].” Alli’s mom wouldn’t let her go into chat rooms until she got like a separate e-mail address that didn’t reveal her real name. Alli replied, “She’s [mom] like, Okay, you can talk to whoever you want to as long as you don’t tell them where you live or your name or anything. I said, Mom, I’m not stupid.”

There was nothing “stupid” about any of these students, whatsoever. In fact, they had looked way ahead in planning for their futures, particularly regarding college majors and career choices. “In college I am planning on going into the Architectural field, so I figured CAD would be pretty good for me” (Eric B., male, grade 9). Erik K. wants to create with computers too. “I hope someday to be able to do something with computers, building them maybe. I think I would like to build more powerful ones” (Erik K., male, grade 9). “I’ll probably use computers a lot because I’m kind of leaning towards being a writer for my career. I already have some books started up, so I think I am going to be using computers a lot to put down my theories, the actual bodies. In college, computers use is growing more and more everyday” (Jake K., male, grade 9). Liz and Melisa were two females interested in a computer-related career. “I kind of want to be a computer programmer, for games, because it’s something that I enjoy.” (Liz B., female, grade 9)

Nevertheless, nearly every student could construct ways in which computer technology would enhance their future worlds of work.

“I am going to work at the United States Army Medical Institute of Infectious Diseases (USAMIID), actually. I read a book called the Hot Zone that I was really interested in. I wanted to work with virus and Ebola. It sounds kind of gruesome, but I like stuff like that. I used the Internet and I went to USAMIID’s homepage and to explore what kinds of degrees and stuff I need to work there.” (Alli, female, grade 9)

At her high school Career Fair, Kate talked to an accountant and an actuary. Both told her they frequently use computers. They said, “Just word processing doesn’t cut it anymore. You
have to know how to use [computers]...to be able to fix it. If you make a mistake, you have to
help the computer. You have to keep learning new skills. You can’t just stop.” Justin says, “I
want to be some type of engineer. They tell me I will use technologies in my field.” Melisa
interjected her career plans, yet makes a self-deprecating statement about mathematics, “Yeah,
I am going to become a computer programmer or something in medicine. There’s too much
math in that, so I might not do that.”

Kristen thought computers would be used in her future field of Veterinary Medicine to
“analyze diseases.” She wondered if vets could “type in symptoms if you didn’t know what it
[the disease] was. It would come up with the disease and the cure. You could keep track of all
the files of animals.” As a marine biologist, Jackie hoped technology would help scientists
make dolphins talk back to people. “Technology would be a really big help, in not just doing
that, but in organizing data, like radar responses. Even if you work at McDonalds, you still
use technology because you are pushing buttons on the thing.”

Lastly, the gifted adolescents in this study posed challenges, not only as respondents
during the Multimedia Mania course, but in their response to the follow-up e-mail member
check. For instance, during the class there were three females in the back row of the class (see
Appendix Figure 5), who spent a great deal of time talking to each other and playing on Instant
Messenger (IM). Through their journaling, they expressed concern that I was intrusive.
Perhaps, I sat behind them too often, appearing to look over their shoulders. However, there
were no out-of-the-way places to observe than in the back row (where they were aligned). I
was, indeed, behind them observing the class, but my observations were regarding the entire
group. This trio, although very knowledgeable using multimedia skills, seemed disinterested
in the course. Perhaps the course progressed too slowly or they were bored with the skills.
Maybe the course description didn’t reflect what they expected to learn. Maybe they wanted
more WWW use and skill development, not multimedia authoring tool use. It was of great
relief to me, however, that all three females immediately responded to the six-month follow-up e-mail questions. They, along with others, provided wonderful, insightful, candid replies.

Gifted adolescent learners can be challenging, opinionated respondents with whom to work and communicate. A few examples of a student's candor included Kristen's criticism of my Macintosh e-mail font which looked different on her home PC!

Kristen: "P.S. Could you stop putting the stuff in bold lettering or different fonts? It comes out like this on my screen and is very annoying. <fontfamily>Times</param><bigger> etc.

Sally: "Sure, no problem."

Another student, Melisa, said she didn't learn a thing from reflecting on my questions.

Sally: "What have you learned about yourself from thinking about all of these questions?"

Melisa: "That I don't like answering stupid questions unless I'm getting paid :)

Rachael, who complained about lack of time for project work, had a sharp edge to her speech.

Sally: "Could you elaborate on your response, rather than replying, 'Nope?'

Rachael: "I said, 'Nope,' because I didn't have any questions. How am I supposed to elaborate on that?"

However, Rachael later replied,

"I don't want to offend people. I don't want to say something that could be interpreted the wrong way. A lot of things that I have said have been interpreted completely different than what I meant them. So, I have been trying to figure how to word it best, so I don't get a result that I wouldn't like."

Finally, in a closing focus group question response, students were asked to give, in one word, their level of confidence using multimedia technology (see Appendix L). Female students described their confidence levels more cautiously than did the males.

Males used (and repeated) these adjectives: "Confident, very confident, great."

Females used these terms: "Solid, pretty good, good, OK, fine, growing, I apply what I know, I am good at imitation."

The females in this study concluded that they significantly increased their sense of competence through acquiring and applying new technology skills. They expressed increased confidence
levels, as they explored their participation in an “engendered” culture of adolescent computer use. Yet more work must be done for educators, teacher-educators, and families to understand the needs and roles of technology-using females and to maximize their potential in the Information Age.

Conclusion

According to qualitative research protocol, the overarching “grand tour research question” (Werner & Schoepfle, 1987) guided the substance of this study. The original inquiry, concerning “What is the experience of adolescent females using multimedia technology for problem solving skills in this setting?” resulted in evidence suggesting that gender disparity in computer use exists in educational environments.

Student multimedia project scores resulted in a relatively wide spread with a very strong correlation of rater’s scores indicating agreement between raters of the general quality of student work. Students skillfully created unique and interesting projects on topics varying from dragons to dolphins. Interestingly, the mean of male scores was higher (84.8) than the female scores (76.7) after projects resulting from the 30-hour course had been completed.

The Use of Computers and Multimedia Technology (UCMT) posttest scores for these students resulted in significantly higher computer skill levels after completing the multimedia course. Yet after completing the same course, male students reported greater levels of confidence than females in developing multimedia technology skills. Significantly, males rated themselves as “confident” to “extremely confident” while females rated themselves as “a little confident” to “confident” after the same 30 hours of multimedia technology training.

Narratives, representing the voice of gifted adolescent students in this study, suggest that early life school experiences and family support are powerful influences on computer-savvy teenagers. Many of these students now have more advanced computer skills than their parents. It was fascinating to learn the various ways students learned those skills not just in school, but as self-taught initiatives outside of the classroom. Students viewed their classroom
teachers as lacking adequate preparation and facility in complex uses of computer technology in
teaching and learning activities. Additionally, students in this study observed few female role
models demonstrating sophisticated uses of technology. Their female teachers using
technology effectively were more likely to teach mathematics or science-related courses.

Gender stereotypical behaviors exist for bright females in the study whether they were
using computers for intentional or recreational purposes. However, these females valued rich
experiences using computer technologies in ways that were personally meaningful over time.
They felt positively influenced by interactions with computer-using peers.

Interestingly, gifted adolescent students in the study insisted there were no gender
differences in male-female use of computer technology among their teachers, peers, or parents.
However, their interview narratives provided interesting evidence to the contrary. Gender
differences were often subtle involving social conversation, expressed competence, and sense
of self-efficacy.

Gifted students in this study were generally impatient with problem solving instruction.
Individuals who valued problem solving seemed to hold greater capacity for developing
complex ideas using computer technology as a tool. Adolescents in the study interacted in a
computer-culture of their own definition outside of the world of adults. They use and invent
communication “emoticons” and perceive application of computer skills in a futuristic sense.

This study contributed to the understanding an “engendered” computer culture limiting
full participation of females in both the educational setting and the workplace. Because we
can’t change what we don’t recognize (Reis, 1987, p. 83), this research sheds light on
understanding the issue of female accomplishment using computer technology for problem
solving ventures.
Acknowledgements

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CHAPTER 5. GENERAL SUMMARY

General Discussion

In that problem solving is a complex phenomenon that requires students to develop and integrate theoretical understandings of facts and processes with critical thinking skills in order to apply knowledge, this dissertation study suggests constructivist learning environments invite support for problem solving proficiency, especially for female students.

The first paper in this dissertation series of articles, Chapter 2, suggests that historically new computer technologies in American education rely heavily on invention, policy-making, and administration of men in government, military, and higher education. However, use of technology in the schools currently depends largely on implementation in classrooms primarily led by women K-12 educators (3:1 ratio). An analysis of literature finds that in the last sixty years of American invention and application of digital technology, changes have occurred exponentially. The number of significant technological changes has multiplied from initial governmental and research purposes to principal developments for instruction in the educational setting. In examining changes in educational technology one decade at a time, this paper highlights the mushrooming use and influence of technology in education since America’s 1940s era of technical industrialization and invention. Major ideas include:

* Little information exists on understanding the history of developing educational technologies with regard to the role of women using computer technology in education.

* While female leadership from an individual such as Grace Murray Hopper or two million women known as “Rosie the Riveters” demonstrated women’s’ technical competence, the post war job departure for women in these areas has not been equalized in the last 60 years.

* Typical educational technologies in the 50s, 60s, and early 70s included use of films, slides, filmstrips, overhead projectors, ditto machines, cassette recorders, and eventually
television, but very little research supported the effect of these media on teaching and learning. However, by the late 80s computer technology was associated with issues of school reform.

* The Internet was an early-60s invention for governmental security in conjunction with university research institutions. Internet-networked computers for large-scale educational use would not be realized for another 30 years. The number of Internet-networked computers has exploded from only 1000 in 1984 to an estimated several billion in just over one decade. Communication technologies have extended distance learning opportunities for students at all levels from elementary school to the university.

* Computer-science degrees and computer-related career choices in the 70s, 80s and 90s continue to be male-dominated. Gender imbalance exists in the classroom as males report higher levels of confidence, see computers as more useful, and attend more camps and classes.

* The disparaging computer gender gap, continuing to distance females from the workforce to the classroom, limits full participation of all students using technology.

In the second paper, Chapter 3, a concise review of problem solving literature suggests that few educators deny the importance of problem solving, yet a wide range of definitions have been used to describe problem solving. However, there is consensus that problem solving is a non-algorithmic path of action involving pursuit of goal involving a sequence of steps or activities. Problem solving involves stimulating mental engagement and is a relatively sophisticated mental ability which is difficult to learn. Major ideas include:

* Problem solving is highly idiosyncratic. Effective problem solving is not only dependent upon one's knowledge, prior experience, motivation, but influenced by individual dispositions that impact problem solving potential. Better predispositions for effective problem solving include self-efficacious beliefs influencing choice of activities, effort expenditure, persistence, and personal judgment about solving problems.
* Better problem solvers use a greater number of self-regulatory strategies and use them more frequently. They have an internal locus of control and are more likely to attribute success to ability and effort rather than to luck.

* Better problem solvers hold an incremental view of their intelligence and are more likely to display a mastery-oriented learning pattern, rather than a helpless motivational pattern.

* Good problem solvers connect knowledge and strategies in meaningful ways and limit competing behaviors, distractions, and emotions.

* Learning environments such as constructivist, optimal, anchored, or situated learning can enhance problem solving activity, in that connecting prior knowledge to current experiences in authentic, meaningful experiences help learners construct new knowledge.

* Learning in knowledge-building communities, in a socially-constructed learning environment, can build the level of potential development of individual students.

* Interacting with multimedia technology can engage learners in multimodal environments that influence students’ problem solving facility.

* While adolescent students (predominantly females) enrolled in a multimedia technology summer course, held various views about problem solving instruction, they clearly used those skills in completing and presenting complex independent multimedia projects at the completion of a 30-hour elective summer course.

* Multimedia technology, used with self-governing tasks to connect learners to relevant content and issues, can be a tool to increase problem solving proficiency in order to facilitate reasoning skills and build expertise.

Chapter 4, the third paper, describes an elective multimedia technology summer course designed for 20 gifted adolescent learners to learn and apply problem solving skills in the development of a multimedia project in a self-determined area of interest. The study examined the differences in perceptions of females and males using computer technology in and out of the classroom, with particular attention to and interpretation of the female experience. The
paper discusses female student perspectives of computer use, including students’ views of peers, parents, and teachers using technology. Moreover, this paper describes an “engendered” (Gilligan, 1993; Lindsey, 1997; Bloom, 1998) adolescent computer culture limiting full participation of females in computer-related experiences. Major ideas include:

* Female adolescent students responded positively to planned interventions (e.g., course advertisements and full-ride scholarships) to invite participation in an elective computer class requiring use of multimedia technology.

* Problem solving instruction (Eisenberg & Johnson, 1996) can be incorporated into a multimedia technology class for gifted adolescents, resulting in increased student skills and confidence, with males reporting higher levels of each.

* A constructivist learning environment (Cadiero-Kaplan, 1999) was potentially a good match for these female students to learn skills in multimedia technology and problem solving.

* Females in this study effectively used technology in complex problem solving activities requiring theoretical understandings of facts and processes with critical thinking skills in order to apply their knowledge to solve specific problems.

* Multimedia computer technology, in conjunction with meaningful content, invited female activity and meaning making for creative, productive learning. Effective use of computer technology was a promising tool to invite females in the study to develop skills and processes necessary to become better problem solvers.

* Females defined themselves through social interaction, connecting and communicating with others, more so than did the boys, throughout the study. Females valued rich experiences using computer technologies in ways that were personally meaningful over time and were positively influenced by interaction with computer-using peers.

* Early life school experiences and family support were powerful influences on computer-savvy teenagers in the study. Both males and female respondents now have more advanced computer skills than their parents.
* Gifted adolescents (male and female) in the study held "engendered" views of computer-use based on experiences in their home and school environments. They viewed computers as a male-dominated domain (Benston, 1988; Turkle, 1988; Shashaani, 1993).

* Gifted adolescent students in the study insisted there were no gender differences in male-female use of computer technology among their teachers, peers, or parents. However, their interview narratives provided interesting evidence to the contrary.

* While gifted adolescents in this study found some educational computing school experiences relevant, most reported that they were largely self-taught and that their classroom teachers lacked necessary computer skills.

* Gifted students in the study were generally impatient with problem solving instruction. Individuals who valued problem solving seemed to hold greater capacity for developing complex ideas using computer technology as a tool.

* Adolescents respondents in the study interact in a computer-culture of their own definition outside of the world of adults and perceive application of computer skills to their future career goals.

"New junctures" for female students to use computer technology for problem solving, according to this dissertation study, are better established in constructivist learning environments inviting all students to use technology meaningfully. Learning in a constructivist paradigm means greater attention is given to the acquisition of higher-order thinking skills, problem solving, and development of innate goals and curiosities (Panel on Educational Technology, 1997; Nicaise & Barnes, 1996). In a constructivist learning environment, the instructor facilitates active learning, inquiry, and reflection. Accordingly, the students are engaged in socially-constructed learning to ask questions and to work cooperatively, collaboratively, and independently.

In summary, effective and equitable use of technology can actually reduce, not exacerbate the existing computer gender gap between males and females in the classroom.
Once students and educators make meaningful uses of technology, learning is never the same again. Computer technology can empower students if used as a tool for individual learning and problem solving and as a tool for group interaction and communication. It can be a “mindtool” tool for critical thinking (Jonassen & Grabowski, 1993; Jonassen, 1996).

To assure equity in computer use, access, and outcomes in the increasing numbers of computers available to students, it is advantageous for educators to understand the historical development of educational technology, problem solving and learning theory, effective use of computers in a constructivist learning environment, and the “engendered” culture of computer-use limiting full partnership of females. The endeavors of this research study will increase the body of knowledge and known strategies influencing the potential of female use of technology for problem solving. Applications of this research, then, may increase proficiency of females as learners, leaders, and scholars of the twenty-first century.

Suggestions for Future Research

Researchers should begin studies of problem solving phenomena using computers much earlier than during adolescent learning years. While the respondents (grades 8-11) in this research study were articulate, opinionated, and responsible communicators of their personal and school experiences, they had already formed general levels of confidence regarding computer-use. Studying early-learners in elementary classrooms or studying the effects of systematically-planned technology interventions of young children, would yield beneficial results to better impact early learners, rather than adolescents.

Researchers might examine the home environments of computer-savvy students. Schools and home environments share responsibility for the gender disparity in computer usage. Home environment is, in part, accountable for the differences. It isn’t enough to merely have access to a home computer. What do families of computer-competent kids do at home? In what ways do some families effectively use computer technology giving their kids a head start in learning and problem solving ability? If we are to progress beyond issues of equal
access, researchers must determine levels of home support, interaction, and activity that empower both female and male competence and confidence using computer technology.

Similarly, researchers might study the school environments of computer-savvy students and their teachers in order to critically observe educators, especially female classroom teachers, who establish environments in which students excel in their use of computers for thinking, reasoning, and problem solving. What kinds of administrative or faculty leadership enhance effective classroom use of computers? What kinds of faculty or inservice training empower a culture of computer-using teachers who skillfully integrate technology into their curriculum? Does it make a difference if educators inform and encourage families to use computers as tools for learning? How do educators facilitate problem solving skills and non-sexist attitudes of their computer-using students? What is the nature of school and community communication about goals and progress using computers at school? In what ways do teacher-educators prepare new teachers to understand issues and practice of using technology for effective learning? Are institutes of higher education partners for success or harnesses maintaining the status-quo?

Finally, researchers would continually benefit from the interpretation of the female learning experience. Important recommendations for research include new questions about “voice” (Gilligan, 1993, p. xv). In reflecting on the experiences of females in this research study, I have come to understand that voice, difference, and development extend beyond what I know at the end of this study. Understanding human “voice” is the “physics of psychology” (Gilligan, 1993), in that analysis of women’s psychological development is a struggle for connection and achievement. When female learners are denied meaningful connections in using computers as tools for communication or productivity, their voices either “fall into a space where there is no resonance or where the reverberations are frightening” (p. xvi). How is the bright, computer-using female silenced or redirected in the “engendered” culture of school? Indeed, “We Can’t Change What We Don’t Recognize,” (Reis, 1987, p. 83).
How are male/female differences, identifiers of the human condition, addressed in the relationships of schooling? How are differences of male and female learners understood by teachers or teacher-educators? In a larger sense, beyond theorizing about whether developmental differences are genetically-determined or socially-encultured, how is “voice” a wellspring for female accomplishment? How can we enculture a new common sense in “new junctures” for female accomplishment?

From the present vantage, we cannot predict the precise features of the innovations that will prove successful, but, one way or another, as educators act on the intuition that new technologies will enable them to reshape pedagogical space and time, they will develop a more effective environment.

We are dealing with innovations that invalidate the common sense that held under prior conditions; our task will be to develop a “new common sense,” suitable for the new conditions. With the old common sense, educational environments were standardized and predictable; with the new, they will be flexible, diverse—a challenge to the imagination. The same will prevail with the strategies of motivation at work in these new environments. (McClintock, 1992, p. 228).

References


APPENDIX A. ADDITIONAL TABLES
Table 1. Student Alias Name and Topic Selections (N=20)

<table>
<thead>
<tr>
<th>Self-Selected Alias Name</th>
<th>Gender</th>
<th>Multimedia Topic Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Betty Sue&quot;</td>
<td>Female</td>
<td>Mars</td>
</tr>
<tr>
<td>&quot;Claire Harper&quot;</td>
<td>Female</td>
<td>Monty Python</td>
</tr>
<tr>
<td>&quot;Chris K.&quot;</td>
<td>Male</td>
<td>Boy Scouts of America</td>
</tr>
<tr>
<td>&quot;Jarod Trent&quot;</td>
<td>Male</td>
<td>Dragons</td>
</tr>
<tr>
<td>&quot;Erik K.&quot;</td>
<td>Male</td>
<td>The Simpsons</td>
</tr>
<tr>
<td>&quot;Red Jones&quot;</td>
<td>Female</td>
<td>Dolphins</td>
</tr>
<tr>
<td>&quot;Korben Lister&quot;</td>
<td>Male</td>
<td>Vincent Price</td>
</tr>
<tr>
<td>&quot;Clover Hagarty&quot;</td>
<td>Female</td>
<td>Paris</td>
</tr>
<tr>
<td>&quot;Neptune L.&quot;</td>
<td>Female</td>
<td>Cats in Outer Space</td>
</tr>
<tr>
<td>&quot;Justin H.&quot;</td>
<td>Male</td>
<td>Jimi Hendrix</td>
</tr>
<tr>
<td>&quot;Carrie F.&quot;</td>
<td>Female</td>
<td>Chicago Bulls Basketball Club</td>
</tr>
<tr>
<td>&quot;Paige LeMay&quot;</td>
<td>Female</td>
<td>Walt Disney</td>
</tr>
<tr>
<td>&quot;Michelle Heiges&quot;</td>
<td>Female</td>
<td>Constellations</td>
</tr>
<tr>
<td>&quot;Iowa Girl&quot;</td>
<td>Female</td>
<td>Mount Vernon</td>
</tr>
<tr>
<td>&quot;Dianne Berger&quot;</td>
<td>Female</td>
<td>Gemstone3</td>
</tr>
<tr>
<td>&quot;Nicole Robinson&quot;</td>
<td>Female</td>
<td>Infant Brain Development</td>
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<td>&quot;Melisa93&quot;</td>
<td>Female</td>
<td>Cardinals Baseball Team</td>
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<td>&quot;Rachel Stew&quot;</td>
<td>Female</td>
<td>Earthly Elementals: Mythological Animals</td>
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<tr>
<td>&quot;Harley Resib&quot;</td>
<td>Female</td>
<td>North American Wolves</td>
</tr>
<tr>
<td>&quot;Morgan Hackney&quot;</td>
<td>Female</td>
<td>Horses</td>
</tr>
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</table>

* Responded as not interested in survey
* Failed to respond to follow-up communication
* Scholarship recipient
Table 2. Scores for Multimedia Mania Projects

SCORES FOR MM PROJECTS-Summer 1998

Total possible: 104 pts in 13 categories 1-8 pt range for each category

<table>
<thead>
<tr>
<th>Student</th>
<th>RawScore-rater #1</th>
<th>RawScore-rater#2</th>
<th>Topic</th>
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<tr>
<td></td>
<td>blue sheet-DK</td>
<td>yellow sheet-SB</td>
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<tr>
<td><strong>Males:</strong></td>
<td></td>
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</tr>
<tr>
<td>M1</td>
<td>80</td>
<td>88</td>
<td>Dragons</td>
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<tr>
<td>M2</td>
<td>92</td>
<td>92</td>
<td>Jimi Hendrix</td>
</tr>
<tr>
<td>M3</td>
<td>71</td>
<td>67</td>
<td>Vincent Price</td>
</tr>
<tr>
<td>M4</td>
<td>87</td>
<td>95</td>
<td>Boy Scouts of America</td>
</tr>
<tr>
<td>M5</td>
<td>86</td>
<td>90</td>
<td>Simpsons</td>
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<tr>
<td><strong>Females:</strong></td>
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<td>F1</td>
<td>91</td>
<td>96</td>
<td>North American Wolves</td>
</tr>
<tr>
<td>F2</td>
<td>80</td>
<td>82</td>
<td>Walt Disney</td>
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<tr>
<td>F3</td>
<td>74</td>
<td>79</td>
<td>Infant Brain Development</td>
</tr>
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<td>F4</td>
<td>72</td>
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<td>F8</td>
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<td>Cats and Outerspace</td>
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<td>F9</td>
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<tr>
<td>F15</td>
<td>51</td>
<td>59</td>
<td>Gemstone3</td>
</tr>
</tbody>
</table>
APPENDIX B. ADDITIONAL FIGURES
Data Gathering Questions: Teachers

Focus Group Questions:
- Describe how your teachers use computer technology. Are there any differences?
- What differences do you see in the way male and female teachers use technology in your school?

Individual Interviews:
- In what ways do most male teachers use the computer in your school?
- Describe the computer technology classes or opportunities at your school.

Member Check E-mail Prompts:
- What computer equipment do you use at school?
- Do your teachers need more training in effective use of computers? Why?

Do your teachers use computer technology. Are there differences?
- How should teachers use computers in your school?

Figure 1. Data Gathering Questions: Teachers
Figure 2. Data Gathering Sources: Peers
Figure 3. Data Gathering Sources: Self
Figure 4. Data Gathering Sources: Teachers, Peers, Self
Figure 5. Multimedia Mania EXPLORATIONS! Student Seating Chart and Topic Choice
APPENDIX C. FLYER TO IOWA TALENT SEARCH FEMALES
Did you know??
• Girls tend to use computers more frequently for word processing, while boys use computers for thinking games, simulations, or as computer programmers (Mark, 1992).

• Boys have significantly more positive attitudes toward computers than girls, who display less confidence in their own computer use (Mark, 1992).

• In boy-girl pairing of classroom activity at the computers, girls tend to be “marginalized” by watching as boys dominate by using the mouse and making navigational decisions (Beisser, 1997).

• Girls are more likely to ask for directions, accept help, or receive teacher “over help” than boys (Kerr, 1994).

• Girls’ attitudes about computers contribute to lower enrollments in computer courses and involvement in voluntary out-of-school computing (Mark, 1992).

• Boys are three times more likely to attend optional computer camps and summer classes, with variations increasing with grade level, program cost, and difficulty levels of the computer course (Hess and Miura, 1985).

• Research data support that there is “gender bias” in student learning of math and science, summarizing concerns that these inequities will be mirrored in the use of computers which are linked with mathematics and science as a male domain (Damrin, 1996.)

Why does it matter if girls are interested in technology?

• Computer technology is relevant to the interests and concerns of girls and women.

• Females can use computers as effective tools in learning and work environments extending beyond the classroom walls to integrate technology in thinking, decision-making, and problem-solving.

• Girls benefit from courses and encouragement to use technology for current work, advanced study or careers involving computer technology.

• As computers become part of our society, it is imperative that we consider equity issues in relation to a tool that has a wide educational, economic, social, and political impact.

• Beyond equal access, psychological, social, and attitudinal factors influencing girls' use of computers can be addressed if girls are willing to engage in experiences and courses involving computer technology.
All students are more likely to be motivated to use computers if they see them as an important tool for accomplishing their own goals. Continued research needs to focus on equity issues in investigating the effects and implications of computer use in the schools.

Are there computer courses or technology explorations for girls?

• YES—In your recent CY-TAG and EXPLORATIONS! Voyages of the Mind Brochure, you learned of many such opportunities. Sign up before classes fill. Classes are mixed gender, but technology courses tend to include predominantly boys.

SEE: ✅ MULTIMEDIA MANIA -EXPLORATIONS! Session I-June 14-20, 1998
✅ Scholarships for girls!
✅ From Logo to Java -EXPLORATIONS! Session II-June 21-27, 1998
✅ Digital Photography -EXPLORATIONS! Session IV-July 5-11, 1998

Enrollment deadline is April 20, 1998. Late enrollments are accepted, if space remains. For enrollment questions call the OPFTAG office at 515-294-1772 from 10 AM-3 PM.

What can educators and parents do?

1) Expose girls to math, science and computer classes and experiences to build skills, abilities, and confidence.

2) Emphasize girls’ effort, ability, and thinking… not neatness, conformity, and appearance.

3) Learn about women in science, math, and technology who have made a difference in the lives of others.

4) Provide girls and young women with strong role models of females who are leading the way, developing skills and abilities, and embracing life especially in career areas using math, science, and technology skills.

5) Apply existent literature to build equitable experiences and support for girls in the classroom. Application of equity research may ensure that both girls and boys are equally challenged and valued in the classroom.

6) Value non-traditional career choices with scholarship dollars and mentorship support systems from secondary school through graduate school. Investigate early career placement and job-shadowing experiences for girls.

Office of PreCollegiate Programs for Talented and Gifted
W-172 Lagomarcino Hall
Ames, IA 50011-3180

This flyer is sent to you by Sally R. Beisser, Multimedia Mania Researcher, Iowa State University, Ames, IA
Questions or comments may be forwarded to sbeisser@iastate.edu
APPENDIX D. SCHOLARSHIP APPLICATION
Scholarship Application
Multimedia Mania EXPLORATIONS! Session I June 14-20, 1998
Return to application to: W-172 Lagomarcino Hall, ISU, Ames, IA 50011

Student Information:
Name: ___________________________ Date: __________________
Home Address:
_____________________________ ____________________________
_____________________________ ____________________________
_____________________________ ____________________________
Home Phone: ___________________ E-mail address: ________________
                             (area code) (if applicable)
School District: __________________ Gender: _______ Ethnicity: ____________
                             (Needed for Exxon scholarship)

Eligibility:
1. Entering grade next fall: _______ (Must have completed grades 7, 8 or 9 as of spring '98)
2. ISU Talent Search Participant: Yes______ No_______
   If not, you may be declared eligible by providing evidence of one of the following:
   * Scoring at or above the 97% (national norms) percentile on the ITBS,
   * Scoring at or above the 93% (Iowa norms) percentile on the ITBS,
   * Scoring at the levels above on other standardized achievement tests, or
   * Submitting a letter of recommendation from a classroom teacher familiar with your academic work. Include a full reference complete with address and phone number along with the letter of support.

Letters of Recommendation:
1. A letter from you, the scholarship applicant, stating your interest in taking the Multimedia Mania course.
2. A letter of recommendation from a teacher or educator who knows your work.

Commitment to Attend Multimedia Mania this summer, JUNE 14-20, 1998
1. _____ I am going to attend this class whether or not I receive scholarship funding.
   (Cost=$475 + $25 lab fees)
2. _____ I can attend only if I receive partial scholarship funding.
3. _____ I cannot attend this class unless I receive full scholarship funding.
**Demonstration of Need:**

1. Documentation of students on free or reduced lunch are automatically considered.

OR

2. A letter indicating financial need from parents/guardians, administrator, counselor,  
   or teacher.

**Signatures:**

\[ \checkmark \] Parent/guardian  \[ \checkmark \] Student applicant

**Other Relevant Information:**

---

**For office use only:**

ExxSch#500  ISUFoun#500  DKGSch#450  GlassSch#500

1.

2.

3.

4.
APPENDIX E. LETTER OF CONSENT
Summer 1998

Dear “Multimedia Mania” Participants:

With increased availability of multimedia technology in classroom learning environments, the goal of this study is to examine problem solving ability and self-efficacy of participants who are using multimedia-capable digital technology. Student facility with multimedia software will be analyzed through:

1. Interest and computer technology-use surveys
2. Small group interviews called “focus groups” during the Multimedia Mania course
3. In-class observations of students working on their projects
4. Examination of final student multimedia projects at the end of the class
5. Follow-up written surveys to be mailed six months after the class has ended

The purpose of this study is to determine how implementation of multimedia technology in an educational setting might enhance problem solving skills and self-efficacy of those students using hardware and software to develop their own multimedia projects. Completion of this study may result in new information for effective use and analysis of student work using multimedia technologies in schools and classrooms. Findings may inform best-practice for teachers and skill development for learners.

Participants’ identities will be held confidential and not used in reporting research information regarding problem solving and multimedia technology. Discussions will be open-ended. Subjects in no way will experience discomfort or harm. Participation is voluntary and participants may withdraw from any part of the study at any time. Inquiries may be directed to Sally Beisser for explanation or clarification.

Sincerely,

Sally R. Beisser, Ph.D. Student
Curriculum and Instruction,
Iowa State University
515-294-1667 (O)

Dr. Ann Thompson, Iowa State University
Director of Center for Technology in Learning and Teaching Laboratories

Dr. Camilla Benbow, Interim Dean
College of Education
Iowa State University

I, ____________________________, give/do not give my permission to be observed and interviewed during this study and that my multimedia project may be viewed.

______________________________
(Signature of parent/guardian)

Date signed: ________________________

Please return the form to Sally Beisser, N-158 Lagomarcino Hall, Iowa State University, Ames, IA 50011 or E-mail your response to sbeisser@iastate.edu
Welcome to Multimedia Mania

Dear “Multimedia Mania” Participants,

You are about to enjoy one of the greatest weeks of your summer during EXPLORATIONS! Session I, June 14-20, 1998. This is an opportunity to develop skills using multimedia technology to design an electronic project of your choice using text, graphics, sound, video from print and Internet resources. During this class, I would like to study the ways in which students solve problems using multimedia technology as part of my Ph.D. studies in Education at Iowa State University.

I invite you to be a participant in my research study. You will be asked to fill out a survey, to answer interview questions in a small group, and to share your electronic project either while you work on it or at the end of the class. Finally, you would respond to one follow-up letter after you’re back in school inquiring about your continued use of multimedia. All of these procedures should not take a total of more than 90 minutes of your time.

Your name and identity will be held confidential. You will be identified by a letter and number as a personal identifier. Discussions will be open-ended in a small group. You will not experience discomfort or harm during the study. Your participation is voluntary and you may withdraw from any part of the study at any time. At the end of the study, data stored on paper, computer disks, or cassette tapes will be destroyed to protect your identity.

The goal of this study is to examine problem solving ability and self-efficacy of students who are using multimedia-capable digital technology. The purpose of this study is to determine how implementation of multimedia technology in an educational setting might enhance problem solving skills and self-efficacy of those students using hardware and software to develop their own multimedia projects. Completion of this study may result in new information for effective use and analysis of student work using multimedia technologies in schools and classrooms. Findings may inform best-practice for teachers and skill development for learners.

I am excited to watch students learn more about technology. I find that I use technology every day to prepare for the university level courses that I teach, to organize information for my research, and to communicate with friends and family in South Africa and Germany. I have my own homepage at ISU. I use my computer about two hours every day. I am glad I’ve learned many skills and want students to have these same advantages for their personal and school use.

Thank you for your participation in EXPLORATIONS! 1998. See you this summer!!

Sincerely,

Sally R. Beisser, Iowa State University
Curriculum and Instruction PhD Student N-158 Lagomarcino Hall
Iowa State University, Ames, IA 50011

sbeisser@iastate.edu (E-mail)
515-294-1667 (Office phone)
http://www.public.iastate.edu/~sbeisser
APPENDIX G. DATA GATHERING INSTRUMENT
Use of Computers and Multimedia Technology (UCMT) 
Questionnaire

The purpose of this study is to examine your experience using multimedia technology in a learning environment. This questionnaire is divided into four parts. In part one and two, you are asked to provide some basic background about yourself and your experience with computers, if any. In part three, you are asked to provide information concerning your experience with multimedia technology. Part four asks you to indicate the extent to which you are confident when using multimedia technology. Thank you for providing this data.

Sally R. Beisser, Iowa State University ©1998

Part 1: Demographic Information

Directions: Please indicate your response by checking the appropriate alternatives, or filling in the space provided.

1. Gender
   □ Female
   □ Male

2. Grade (as of fall '98)
   □ 8th
   □ 9th
   □ 10th
   □ 11th
   □ 12th

3. Age
   □ 13
   □ 14
   □ 15
   □ 16
   □ 17

4. State
   □ IA
   □ MN
   □ NE
   □ KS
   □ MO
   □ WI

   Other ___

4. Secondary School Enrollment:
   Estimate the size of your high school: (Check one)
   ■ Very large (over 1350 students)
   ■ Large (800-1350 students)
   ■ Medium (350-800 students)
   ■ Small (under 350 students)

5. High School Graduating Class Size: (Check one)
   Estimate the size of your graduating class:
   ■ Very large (over 300 students)
   ■ Large (175-300 students)
   ■ Medium (75-175 students)
   ■ Small (under 75 students)

6. Computer Technology Instruction:
   What exposure have you had in using computers in learning? (Check all that apply)
   ■ Taken a semester credit class during school (computer programming or keyboarding).
   ■ Taken a class out of school (college class, community education, summer, etc.).
   ■ Had technology instruction during class, but not a whole semester of training.
   ■ Had technology instruction as part of another subject (such as science or reading).
   ■ No formal instruction—I figured it out alone or with peers.
   ■ No use of computers whatsoever.
7. Multimedia Technology Instruction: Describe your experiences in A or B.
A. □ No use of multimedia technology whatsoever or do not know what “multimedia” means. If you checked A complete ONLY Parts 2 and 4 on the next two pages. Thank you.

B. If you have used multimedia technology, complete Parts 2, 3, & 4. (Check all that apply)
☐ Taken a semester credit multimedia class during school.
☐ Taken a multimedia class out of school (community or campus course).
☐ Had multimedia technology instruction during class, but not a whole semester.
☐ Had multimedia technology instruction as part of another subject or for projects.
☐ No formal multimedia instruction—I figured it out alone, with peers, or adult help.

Part 2: Computer Experience

Directions: Please indicate your response by checking the most appropriate box.

1. Please select the computer applications you have used (mark all that apply).
   □ Word-Processing.
   □ Spreadsheets.
   □ Databases.
   □ Electronic Presentations (e.g. Power Point).
   □ Electronic Communication (E-mail, chat-lines).
   □ Desktop Publishing (e.g. Pagemaker or Claris Works).
   □ Multimedia Authoring (e.g. Hyperstudio).
   □ Created a WWW homepage (e.g. HTML).
   □ Internet searches for school or personal use
   □ Do not use the computer at home or school.

2. Do you use a computer at home?
   □ No.
   □ Yes. If yes, what kind(s)?
     _____________________________
   □ Not sure.

3. Do you use a computer at school?
   □ No
   □ Yes. If yes, what kind(s)?
     _____________________________
   □ Not sure.

Part 3: Multimedia Technology Experience (continued on next page)

1. Please indicate multimedia software you have used (Check all that apply).
   □ HyperStudio®
   □ Power Point®
   □ m-Power®
   □ Digital Chisel®
   □ Linkway®
   □ Authorware®
   □ MacroMedia Director®
   □ Astound®
   □ Other:
   Web page authoring software □ __________

2. What skills have you used in multimedia technology? (Check all that apply).
   □ Added text (words, titles, phrases, etc.)
   □ Added graphics (images, pictures, icons)
   □ Scanned in graphics using a scanner
   □ Added sound from a sound file
   □ Recorded my own sound
   □ Connected buttons to documents/applications
   □ Made “buttons” for non-linear navigation
   □ Connected a program to Internet sites
   □ Created new cards, stacks, slides, pages
   □ Used a digital camera for photographs
   □ Imported video or movie graphics
   □ Created or drew my own graphics
   □ Created my own animation
Created my own video with editing equipment
Created my own WWW homepage.

3. What processes have you used in multimedia technology? (Check all that apply).

- Developed a topic or theme using multimedia software and additional technologies.
- Developed links for navigation of the project.
- Developed non-linear trail to navigate a project independently.
- Used time management skills to complete a multimedia project in a timely manner.
- Used concept mapping to sketch ideas on paper before developing them electronically.
- Used research skills for information and content to build ideas.
- Used organizing and planning skills to represent ideas.
- Used reflection to think about the multimedia project during and after working on it.
- Used presentation skills to share the project with an appropriate audience.
- Used knowledge to construct (think of) my ideas in a multimedia project.
- Used knowledge to represent (depict) my ideas in a multimedia project.

**Part 4 Multimedia Self-Efficacy**

*Directions*: Below you will find a number of statements concerning your confidence using multimedia-capable digital technology. Please circle the number below that best describes how you feel about each statement using the 4-point scale provided.

**My confidence level for performing this task is:**

<table>
<thead>
<tr>
<th>Not confident</th>
<th>A little confident</th>
<th>Confident</th>
<th>Extremely confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Selecting Software and Hardware:**

1. Choosing appropriate software to create a multimedia project. 1-2-3-4
2. Knowing if my computer can support the software for a multimedia project 1-2-3-4
3. Using multiple floppy disks or a zip disk and zip drive to store & save the project. 1-2-3-4
4. Knowing what accessories to use to incorporate more elements into the design. 1-2-3-4

**Using Multimedia Equipment:**

5. Adding graphics (images, pictures, icons) 1-2-3-4
6. Scanning in graphics using a scanner 1-2-3-4
7. Adding sound from a sound file 1-2-3-4
8. Recording my own sound 1-2-3-4
9. Importing video or movie graphics 1-2-3-4
10. Making "buttons" for non-linear navigation 1-2-3-4
11. Connecting multimedia program to Internet sites 1-2-3-4
12. Using a digital camera for photographs 1-2-3-4
13. Creating 2-D graphics 1-2-3-4
14. Creating animation for moving graphics 1-2-3-4
Completing and Presenting a Multimedia Project:

15. Developing a topic or theme using multimedia software and additional technologies. 1-2-3-4
16. Developing links or "buttons" for navigation of a project. 1-2-3-4
17. Developing non-linear trail to navigate a project independently. 1-2-3-4
18. Using time management skills to complete a multimedia project in a timely manner. 1-2-3-4
19. Using concept mapping to sketch ideas on paper before developing them electronically. 1-2-3-4
20. Using research skills for information and content to build ideas. 1-2-3-4
21. Using organizing and planning skills to represent ideas. 1-2-3-4
22. Reflecting and thinking about the multimedia project during and after working on it. 1-2-3-4
23. Presenting or sharing the project with an appropriate audience. 1-2-3-4
24. Using my knowledge to construct (think of) ideas in a multimedia project. 1-2-3-4
25. Using my knowledge to represent (depict) ideas in a multimedia project. 1-2-3-4

---

Thank you

For responding to this survey! Please return this form by June 8, 1998.

Mail this form to:
Sally Beisser
N-158 Lagomarcino Hall
Iowa State University
Ames, IA 50011
APPENDIX H. FEEDBACK TO PARENTS
Dear “Multimedia Mania” Students and Families,

We are finally forwarding comments to you regarding your multimedia project. Jason, the Multimedia Mania instructor, has been busy with his wedding plans. Everyone else has returned to a summer of university classes, professional presentations, or travel.

Enclosed is a Multimedia Rubric that reflects a single score from trained observers who watched and helped students throughout the week. The scores reflect the mean of their numerical evaluations on your final project and presentation on the last day of class. Of the 20 students in the class, no one has a “perfect” electronic project. It is rare to get an “8” for a score in any category. Everyone has several skills to further develop in multimedia technology. Ways to improve may include better initial project planning, greater skill development in learning or using multimedia authoring tools, more time to work, or perhaps greater diligence while completing a multimedia project.

Student topics were varied and interesting! Below are Multimedia Mania final projects presented on the last day of class.

Boys Scouts of America
Cardinals Baseball Team
Cats and Outerspace
Chicago Bulls
Constellations
Dolphins
Dragons
Earthly Elementals: Animals in Mythology
Gemstone3 Online Game
Horses
Infant Brain Development
Jimi Hendrix
Mars
Monty Python
Mount Vernon, Virginia
North American Wolves
Paris
The Simpsons
Vincent Price
Walt Disney
Overall, the student multimedia projects were awesome. Final projects reflected careful planning of a researched topic using applications of new skills in multimedia technology. We felt quite pleased!

The Multimedia instructors and lab assistants learned ways to improve too!! We observed several trends.

1. Mac vs. PC users--

Some students had extensive experience with PCs at home, although most students used Macs in their home schools. The Mac computers available at the Ames Middle School lab, for some kids, were just too slow. Others did not protest. However, our instructional multimedia software was Mac formatted so we had to use a nearby Mac lab. On ISU’s campus, labs were full of ISU summer school students. Notably, the comfort level of the multimedia applications they created was independent of their preference of operating systems. Multimedia Mania students were fast learners regardless of the program platform. If a PC lab were available another year, we would certainly explore PC software and available time in a PC computer lab. This may highlight a trend for schools to provide both platforms for hardware and software.

2. The kids were savvy Internet users--

This highlights another trend. Students came to the class as experienced Internet users. Not only did students use WWW sites for their project research, most used interesting URL’s as hotlinks within their final projects. Some had already authored their own home pages, all but one student had E mail (which they checked frequently during class—sometimes too frequently), and all had used the Internet as a tool for learning, recreation, and communication. As the Web becomes a universal forum for communication and publishing, it may soon be possible that multimedia applications will become platform independent and that student work will be accessible by more users regardless of the system they are operating. (No more zip disks that are an inconvenient fit in computer disk drive near you.) This trend may require educators to more skillfully direct student expertise in using the Internet for instruction, communication, and higher levels of challenge.

3. Students learned by interacting with others--

There were very few moments of silence in the lab all week. Although no two students ever shared a computer, they were constantly engaged with the persons seated next to them. Students asked questions of one another, watched what advanced users were doing, observed the projects of others, and had freedom to use their time as they needed. Not everyone asked for help as they worked. If there were problems, they would report what was wrong, try to figure it out, lean over to another student, and as a last resort ask an adult. Despite the 1:7 adult to student ratio, the adults were often “trouble-shooters” to help students solve problems they were already in the process of solving themselves! Students worked and interacted through lunch. The lab was always busy. They never took the 90 minute scheduled break for lunch and relaxing (of course, it could have been those torrential summer rainstorms and lightning that kept them in the lab!). This trend may encourage educators to see the value of computer lab learning environments as situations for mutuality in learning, not in isolation at a
single computer monitor. Learning is a social activity and learning with computers continues to be a social activity for these students.

4. Planning and problem solving techniques are not universally accepted—

We observed that for some students project planning, storyboarding, and problem solving skill development such as *The Big Six Approach to Information Problem Solving* by Drs. Eisenberg and Berkowitz are inhibiting factors rather than enhancements in creating electronic projects. They did not want to think about planning or problem solving. Some students remarked that these exercises slowed them down or seemed confusing. Some just wanted to build their multimedia project as desired without the conceptual understanding first. Learning and applying problem solving skills seemed as palatable as a dose of cod-liver-oil! Other students argued solidly that the Big Six Skills were life skills that transferred in other subjects and disciplines. They suggested that the problem solving skills helped them better use their time or see the big picture of their project. Among our students there was, however, a correlation with good planning or acceptance of problem solving skill instruction and higher final project scores.

5. Gender Differences and Computers??

It is too early to report about this one. There are hours of student focus group discussions and responses to interview questions that are not yet transcribed, coded, analyzed, and interpreted. This is such an interesting topic that bears thoughtful and systematic research. That results from this group of students will not parallel what the current literature suggests is a likely outcome. There were differing opinions amongst our students. Some critically distinguished differences in the ways in which boys and girls use computers while others objected saying there is not any discernible difference. Some students reported male/female technology-using differences within their instructional environment at school. Others say no differences exist at school. They thought teachers were equal users. Perceptions of gender difference was a hot topic during some student exchanges. More on this subject is to be discovered. Although this is purely conjecture, it could be that with gifted learner's competency is not so much gender-based, but dependent upon intrinsic interest, opportunity, and motivation to use computer technology in personally rewarding ways. More questions need to be asked.

This course was personally rewarding to the staff who designed and facilitated the course. Thanks for allowing your son or daughter this opportunity to come to ISU for EXPLORATIONS! Your follow-up thoughts are always welcome.

Sincerely,

Sally R. Beisser, Iowa State University
sbeisser@iastate.edu

and

Jason L. K., XXXX Community Schools
APPENDIX I. INTEREST INVENTORY
Interest Inventory - Multimedia Mania
Iowa State University

Student Name: ____________________________ Date: ____________________________

Home Address: ________________________________________________________________
Address ____________________________ city ____________________________ state zip

Home Phone: ____________________________ E-mail address: ____________________________
(area code) ____________________________

Entering grade next fall: _______ School District: ____________________________

THINKING BACK:

1. List your favorite school subjects. Why do like them?

2. What are your extra-curricular activities or outside of school activities?

3. List any interesting or unusual hobbies or collections:

4. Name three famous people (living or deceased) who you would like to learn more about.
   (Name of person) ____________________________ (Why are they famous?) ____________________________ (What would you like to know?) ____________________________
   *
   *
   *

5. Is there an event in history or something from the past you would like to study? (e.g.; The Battle of Gettysburg or medieval weapons)
6. If you could learn about a famous place, what place would that be? (e.g.; Stonehenge)

THINK ABOUT NOW:

7. What do you spend most of your time reading about? (Think of topics in the books and magazines you read for pleasure).

8. In general, what topic do you wish you could learn more about?

9. If you had time to yourself to learn anything you wanted, what would you learn?

10. If you could explore a social issue or concern, what would that be?

THINK ABOUT YOUR ELECTRONIC PROJECT:

Look over your previous responses. Your primary interests are most likely represented in one or more of your answers. Name your top three areas of interest.

* 
* 
* 

Narrow your choices above to one favorite. Write it on the line below?

__________________________________________________________________________________

You will gather information from books, the Internet, videos, scanned graphics and images in order to prepare an electronic project. What resources could you bring or check out to prepare this project?
List resources here:  (Don’t forget to bring these resources to ISU for class)

If you could give your chosen topic a creative title, what would that be?

Dear Multimedia Mania Participants:
June 1, 1998

As you prepare for your ISU Multimedia Mania class in about a week, you need to come to this class with a specific topic in mind. For that reason, this Interest Inventory will help you determine a topic of your choice!

Fill this out at home. Bring it to Multimedia Mania class on your first day. Bring ANY materials you think may help you develop your multimedia project. This will help your project be as professional as possible. Here are just a few suggestions:

- Books, Magazines, Journals on your topic
- Photographs to scan
- Videos or video tapes
- Music CD’s or cassettes that can be integrated in your project
- Pre-selected website addresses (URL’s)

Remember to return the other materials to OPPTAG by June 5, 1998 in the envelope provided for your mailing convenience.

Congratulations on your summer selection to take Multimedia Mania. On our final class day, you will have an opportunity to share your project with others. Your parents/guardians will view it on Saturday before you depart.

Sincerely,

Sally R. Beisser, Multimedia Mania Researcher
abeisser@iastate.edu

and

Jason Kurth, Multimedia Mania Instructor
jlkurth@iastate.edu
APPENDIX J. MULTIMEDIA TRAINING MATERIALS
EXPLORATIONS! Multimedia Mania Skills and Activities
Training Materials

Prepared by Jason K. (instructor) and Sally R. Beisser (researcher)

1. Introductions - group activity to get them to know one another
2. Overview of workshop
3. Pretest for research project
4. Examples of student authored multimedia project and other projects
5. Overview of multimedia technology
6. Introduction to Big6 Skills
7. Activity with Big6
8. Planning a Project-Storyboarding steps
9. HyperStudio Basics
10. Journal Writing
11. Exploration time for print material in the media center/library services area of school
12. Back to planning a project
13. Integrating the Big6 into the planning process
14. Using the Internet for research, (copyright cautions=guest speaker)
15. Using print media and CD-ROM technology for resources
16. M-power overview
17. Exploration time
18. Wrapping up the planning process
19. Journal Writing
20. Critical features of HyperStudio and/or M-power
21. Scanners and Digital Cameras
22. Advance features of HyperStudio
23. Work time
24. Journal Writing
25. Student/instructor meeting (one-to-one)
26. Audio/Sound Imports
27. Adding Quicktime movies
28. Project worktime
29. Journal writing
30. Post-test for research project
31. Focus Groups
32. Time to prepare projects for presentations
33. Final Presentations to the group
34. Journal writing
35. Final Presentations for Parents, Family, Guests

Home Work Assignments are listed on the following pages:
Homework Assignments and Journaling Prompts

Day #1-Monday

☐ 1. Create a story map to develop your project idea. You may want to use the form included or create your own story map. You may add to this throughout the week (see Storyboarding Planning Sheet).

☐ 2. Draw a picture of YOUR typical use of computer. Include action and other people, if you wish. You may also draw yourself working alone. (see picture sheet)

In this picture, you must:

A. Label people in your picture, including yourself. Give a specific label, such as “John, my 16-yr-old brother” or “Julie, my 8th-grade friend.”

B. Label what you are doing at the computer in your drawing. Be specific, such as “Doing creative writing for English, finishing a spreadsheet for algebra, playing computer games, presenting my History Day project on the Civil War, or checking my E mail, etc.”

C. Use markers, crayons, colored pencils, or shading, etc. Be colorful. Add interesting details to clarify your drawing.

Day #2-Tuesday

☐ 1. Give two examples of how you use the Big6 Information Problem Solving-Skills© on a daily basis. Give two personal examples for each of the six skill areas. Think about other areas of your life during which you use problem-solving skills to complete homework, create projects, or to make a personal decision. (See Big6 Problem-Solving Sheet).

☐ 2. Journaling: “How do you envision your use of computer technology during the rest of your school years (through high school and college)?”

☐ 3. Take home quiz on HyperStudio/M-power

Day #3-Wednesday

☐ 1. Journaling: “How do you envision your use of computer technology during your adult years in your job or your personal life?”

☐ 2. Finish your Storyboard Planning Sheet

Day #4-Thursday
1. **Journaling:** Write a letter to your parents/guardians telling them the following:

A. Describe the skills you learned this week in Multimedia Mania.

B. Describe your attitude about using computer technology.

C. Describe your confidence in using computer technology.

D. In your opinion, do males and females use computers differently? Support your reply with examples?

2. **Multimedia Mania Project Evaluation:**
   Self-Evaluation and Group feedback

**Day #5-Friday**

1. Complete the **Big6 Information Problem-Solving** sheet on your own MM project!

2. Write a letter to Jason detailing positive aspects of the MM class and what could be changed or improved for next time.

(Do Monday) **A Picture of MY Typical Computer Use**
Give 2 personal examples for each of the six skill areas. Think about other areas of your life during which you use problem-solving skills to complete homework, create projects, or to make a personal decision.

1. **Task Definition:** (Defining and identifying a problem/task)
   a.  
   b.  

2. **Information Seeking Strategy:** (Brainstorming all possible sources/solutions and selecting the best ones)
   a.  
   b.  

3. **Location and Access:** (Locating sources and finding information within those sources)
   a.  
   b.  

4. **Use of Information:** (Hearing, seeing, reading information and extracting relevant information)
   a.  
   b.  

5. **Synthesis:** (Organizing information from multiple sources and presenting the result)
   a.  
   b.  

6. **Evaluation:** (Judging the result and judging the process)
   a.  
   b.  

Do you ever **think** about the process of solving problems? yes or no? Why?
(Do Tuesday) Final Journaling:

“How do you envision your use of computer technology during the rest of your school years (through high school and college)?”

(Do Wednesday) Journaling: “How do you envision your use of computer technology during your adult years in your job or your personal life?”

(Do Thursday) Journaling: Write a letter to your parents/guardians telling them the following:

A. Describe the skills you learned this week in Multimedia Mania.

B. Describe your attitude about using computer technology.

C. Describe your confidence in using computer technology.

D. In your opinion, do males and females use computers differently? Support your reply with examples?

(Do Friday) Using the Big6 Problem Solving-Skills in MM ©1988 Eisenberg & Berkowitz

Think about your multimedia mania project. Give examples for each of the six skill areas as you completed your project this week.

1. Task Definition: (define and identify a problem/task during your MM project)
   -
   -

2. Information Seeking Strategy: (brainstorming all possible solutions and select the best ones)
   -
   -
3. **Location and Access:** (Locate sources and find information within those sources)
   
   -
   -

4. **Use of Information:** (Hear, see, read information and extract relevant information)
   
   -
   -

5. **Synthesis:** (Organize information from multiple sources and present the result)
   
   -
   -

6. **Evaluation:** (Judging the result and judging the process)
   
   -
   -

Have you increased your ability to think about the process of solving problems? yes or no? Why?

Please Explain:

(Do Friday) **Journaling:** "Write a letter to the instructor detailing positive aspects of the MM class and what could be changed or improved for next time."
APPENDIX K. MULTIMEDIA SCORING RUBRIC
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<th>Category</th>
<th>Legend in Your Own Time</th>
<th>Excellent</th>
<th>Fair</th>
<th>Good</th>
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## Multimedia Assessment Tool - Side 2

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<td>Shows some command of computer and software used. Few, if any, errors.</td>
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<td>Minimal use of computer and software capabilities. Some problems with program and equipment operation.</td>
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**COMMENTS:**

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<th>Pts. Side 2</th>
<th>Total Points</th>
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APPENDIX L. FOCUS GROUP QUESTIONS
Multimedia Mania EXPLORATIONS! Course  
June 14-20, 1998  
Iowa State University

Focus Group Questions:

1. (Ice Breaker—Decision-making)  
   *What is your first name. Describe your first experience with a computer.*

2. (Acquisition and transmission of computer skills)  
   *Describe how you most frequently use computer technology both at school and at home.*

3. (Utility questions about computer skills AND/OR problem-solving skills; Attitude transfer)  
   *How will you apply the skills learned in the Multimedia Mania course?*

4. (Problem solving abilities using computers)  
   *In what ways do you think computers help you solve problems?  
   Couldn't you solve these same problems without using computers?*

5. (Gender Disparity)  
   *What differences do you see in the way males and females use computers in your school or at home? Thought prompts:. peers-guys/girls...M/F  
   teachers.....Mom/Dad/guardian*

6. (Gender Implications)  
   *What implications are there for being “good with computers?”  
   What does this mean for girls?....What does this mean for guys?*

7. (Final Go Round—Self-efficacy—question reframed for male focus groups)  
   *In one word, describe your level of confidence in using multimedia-enhanced technologies?*

*Note: Focus groups will meet for 60 minutes minimum. Focus groups will be gender balanced with membership of 6-7 students per group. The group meetings will take place on site (Ames Middle School) during the summer multimedia course on the last class period. Questions were developed then discussed with Dr. Mandy Anderson, RISE, Iowa State University. Recording of data will include audio cassette taping and hand-written notation by facilitator. Data will be transcribed by recorders following the focus group with subsequent analysis by the researcher, Sally R. Beisser.*
APPENDIX M. IOWA STATE UNIVERSITY
HUMAN SUBJECTS FORM: SUBJECTS APPROVAL
Information for Review of Research Involving Human Subjects
Iowa State University
(Please type and use the attached instructions for completing this form)

1. Title of Project: The Effects of Multimedia Technology on Problem Solving Competencies and Self-Efficacy of Gifted Adolescent Students

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are protected. I will report any adverse reactions to the committee. Additions to or changes in research procedures after the project has been approved will be submitted to the committee for review. I agree to request renewal of approval for any project continuing more than one year.

Sally R. Beisser
Typed name of principal investigator
2/2/98 Date
Signature of principal investigator

Curriculum and Instruction
Department
N-158 Lagomarcino Hall, I.S.U.
Campus address

515-294-1667 (o) 515-292-2566 (h)
Phone number to report results

3. Signatures of other investigators Date Relationship to principal investigator

Dr. Kim Thompson, Professor

2/2/98 Major Professor

Dr. Camilla Benbow, Professor

2/2/98 Major Professor

4. Principal investigator(s) (check all that apply)

☐ Faculty ☐ Staff ☒ Graduate student ☐ Undergraduate student

5. Project (check all that apply)

☒ Research ☒ Thesis or dissertation ☐ Class project ☐ Independent Study (490, 590, Honors project)

6. Number of subjects (complete all that apply)

# adults, non-students # ISU students 12 # minors under 14 13 # minors 14 - 17

(This group of students is not formulated yet-this is an estimation.)

7. Brief description of proposed research involving human subjects:

Please see attachment:

8. Informed Consent

☒ Signed informed consent will be obtained. (Attach a copy of your form.)

☐ Modified informed consent will be obtained. (See instructions, item 8.)

☐ Not applicable to this project.
9. **Confidentiality of Data**: Describe below the methods you will use to ensure the confidentiality of data obtained.

Individuals voluntarily participating in the Multimedia class during June 14-20, 1998 (8:30-4:00 daily) will be referred to by first name during the course instruction. Collected or reported research data will not disclose the name or identity of individual participants, but code data of male students as M#1, M#2, M#3 and so forth. Personal identifiers for female students will be similarly coded as F#1, F#2, F#3, and so forth. Data will be analyzed by gender. Names of secondary schools of students will not be disclosed but described by relative size of the population of high school secondary students (e.g., very large, large, medium, small). The research summary will refer to Midwest secondary students, grades 7-11. Group data will be reported. Any and all data collection devices, such as cassette tapes or computer disks, will be discarded after the study is completed.

10. **What risks or discomfort will be part of the study?** Will subjects in the research be placed at risk or incur discomfort? Describe any risks to the subjects and precautions that will be taken to minimize them. (The concept of risk goes beyond physical risk and includes risks to subjects' dignity and self-respect as well as psychological or emotional risk. See instructions, item 10.)

Although there are no major anticipated discomforts or risk factors for participating students, they may experience a lack of anonymity as they self-report perceived competencies and problem-solving strategies for developing electronic independent projects using multimedia technology. See item #9 for confidentiality of data. Students will be treated with dignity and respect during the class and during follow-up interviews or written correspondence.

11. **CHECK ALL** of the following that apply to your research:

- □ A. Medical clearance necessary before subjects can participate
- □ B. Administration of substances (foods, drugs, etc.) to subjects
- □ C. Physical exercise or conditioning for subjects
- □ D. Samples (blood, tissue, etc.) from subjects
- □ E. Administration of infectious agents or recombinant DNA
- □ F. Deception of subjects
- □ G. Subjects under 14 years of age and/or Subject 14 - 17 years of age
- □ H. Subjects in institutions (nursing homes, prisons, etc.)
- □ I. Research must be approved by another institution or agency (Attach letters of approval)

If you checked any of the items in 11, please complete the following in the space below (include any attachments):

**Items A—E** Describe the procedures and note the proposed safety precautions.

**Items D—E** The principal investigator should send a copy of this form to Environmental Health and Safety, 118 Agronomy Lab for review.

**Item F** Describe how subjects will be deceived; justify the deception; indicate the debriefing procedure, including the timing and information to be presented to subjects.

**Item G** For subjects under the age of 14, indicate how informed consent will be obtained from parents or legally authorized representatives as well as from subjects.

Three months before the Multimedia Mania course is offered, parents and participating students will be sent information packets introducing the course instructor and facilitator, expectations for the course content, and what to bring to ISU campus before class. The Written Letter about the research and Consent Letter will both be in the packet mailed in advance to the participating students in care of their parent/guardian. At the first parent meeting (June 14, 1998), the consent letter will be discussed and any concerns will be addressed.

**Items H—I** Specify the agency or institution that must approve the project. If subjects in any outside agency or institution are involved, approval must be obtained prior to beginning the research, and the letter of approval should be filed.
Checklist for Attachments and Time Schedule

The following are attached (please check):

12. X Letter or written statement to subjects indicating clearly:
   a) the purpose of the research
   b) the use of any identifier codes (names, #s), how they will be used, and when they will be removed (see item 17)
   c) an estimate of time needed for participation in the research
   d) if applicable, the location of the research activity
   e) how you will ensure confidentiality
   f) in a longitudinal study, when and how you will contact subjects later
   g) that participation is voluntary; nonparticipation will not affect evaluations of the subject

13. X Signed consent form (if applicable)

14. □ Letter of approval for research from cooperating organizations or institutions (if applicable)

15. X Data-gathering instruments Interest Inventory Included—Data Gathering Instruments still being developed

16. Anticipated dates for contact with subjects:

   First contact
   
   June 14, 1998
   Month/Day/Year

   Last contact
   June 1999
   Month/Day/Year

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:

   By January 2000
   Month/Day/Year

18. Signature of Departmental Executive Officer

   Dr. Richard Zbarski
   Date
   2.3.98

19. Decision of the University Human Subjects Review Committee:

   □ Project approved   □ Project not approved   □ No action required

   Patricia M. Keith
   Name of Committee Chairperson
   Date
   Signature of Committee Chairperson
ATTACHMENTS: S. Beisser

Brief Description of Proposed Research:

During Iowa State University's CY-TAG Residential Explorations Course June 14-20, 1998 I will be conducting research during a week-long class called "Multimedia Mania" which will have a maximum of 25 adolescent participants. High ability students eligible for the course will have completed grades 7-10 and demonstrated exceptional scores on the SAT, ACT, ITBS, or other standardized tests. Course eligibility is determined by the OPPTAG office in W-172 Lagomarcino Hall. Students self-select Exploration classes on a tuition-paying basis. Interested students will preregister for the Multimedia Mania course in April of 1998. Using the Ames Middle School Computer Lab for daily instruction, each student in the course will develop a multimedia project during the week on a topic of their choice. Students develop their electronic independent research study using one of several kinds of multimedia software explored at the beginning of the course.

With increased availability of multimedia technology in classroom learning environments, the goal of this study is examination of problem solving ability and self-efficacy of participants who are using multimedia-capable digital technology. Student facility with multimedia software will be analyzed through the following:

1. Interest and computer technology-use surveys administered before the course
2. Personal interviews with participants individually or in small focus groups
3. Observation of students during the multimedia class while working on projects
4. Examination of final student multimedia projects at the end of the class
5. Follow-up written surveys to be mailed six months after the class

The purpose of this study is to determine how implementation of multimedia technology in an educational setting might enhance problem solving skills and self-efficacy of those students using hardware and software to develop their own multimedia projects. Completion of this study may result in new information for effective use and analysis of student work using multimedia technologies in schools and classrooms. Findings may inform best-practice for teachers and skill development for learners.

Participants identity and names will be held confidential and not used in reporting research information regarding problem solving and multimedia technology. Subjects will not expect to experience discomfort or harm. Participation is voluntary and subjects may withdraw from any part of the study at any time. Inquiries may be directed to me for explanation or clarification.
To: Dr. Patricia Keith, Human Subjects
Iowa State University

From: Sally R. Beisser
Curriculum and Instruction
PhD Student

Date: 5-14-98

Research Title: The Effects of Multimedia Technology on Problem Solving Competencies and Self-Efficacy of Gifted Adolescent Students

Please Note:

My Human Subjects approval was dated 2-9-98 with the instructions to provide data gathering documents which will be used in the research process.

Enclosed, you will find the documents to gathering data. They include:

1. Multimedia Survey Document (3 pages)
2. Interest Inventory Document (2 pages)
3. Focus Group questions (1 page)......no individual interviews will take place.

Thank you.

Sally R. Beisser

Approved of the understanding of ID# will be used instead of subjects' names.

PKAY
5-15-98
APPENDIX N. INDEPENDENT PERSONAL SERVICE CORRESPONDENCE
Dear Multimedia Participants:

Thank you for responding to all of my question sets by e-mail. Your responses were great! If you haven’t checked your e-mail lately, you may have a few more questions to finish. Please check!

Next, you need to mail back the enclosed Independent Personal Service Form in order to get your $20 check processed as reimbursement for your electronic communication which was for my research purposes.

1. Fill out the form (Exhibit A)
2. Mail the form back in the addressed ISU envelope provided

Then your personal check will follow as soon as the university processes it. Try to be patient because large institutions such as a university accounting office take time to get even small jobs done. Your opinions were very important to the process of my research on adolescents and the culture of computer technology. Thanks for your time and ideas.

Have a wonderful summer!

Sincerely,

Sally R. Beisser, Ph.D. August 1999
College of Education
Iowa State University
Ames, IA 50011
sbeisser@iastate.edu

PS Keep this letter until you get your check. Notify me if you are still waiting after 4 weeks.
Exhibit A

Independent Personal Service

The purpose of this form is to obtain information in order to comply with the Internal Revenue Service Regulations under Code Sec. 3402, paragraph 6490 (Federal Tax Guide), on withholding for independent personal service income. The information provided herein will be used to prepare appropriate filings with the IRS. If U.S. residents or citizens do not provide social security numbers on this form, all personal service payments made to them by Iowa State University will be subject to 20% withholding.

Please answer all applicable items listed below: (PLEASE PRINT)

1. Name: ____________________________________________

2. Address: __________________________________________

3. Social Security Number: ____________________________

4. Are you a U.S. citizen or a resident of the U.S. or U.S. territories?
   _____ Yes   _____ No (If no, indicate if you are a refugee.) _____ Refugee

If you are not a U.S. citizen or a resident of the U.S. or U.S. territories, your independent personal service payments made to you by Iowa State University will be charged at a tax rate of 30% to be withheld unless you are subject to a tax treaty, Form 8233 must be completed and attached to the honoraria voucher.

NOTE: Iowa State University is responsible only for proper withholding and reporting. Tax liability and refunds of withholding, if applicable, are determined at the time of filing Form 1040NR with the IRS.

Date ______________ ____Signature of Person Providing Service

The departmental representative to contact for questions about information filled in on this form is Phyllis Kendall, N131 Lagomarcino Hall, ISU, Ames, IA 50011 (515-294-7021).

Iowa State University requests this information for the purpose of processing payment to the individual indicated. No persons outside the University are routinely provided this information (except as previously noted to comply with IRS regulations). Responses to all items are required. If you fail to provide the required information, the University may be unable to process any payments to this individual.
APPENDIX O. RESEARCH TIMELINE
RESEARCH TIMELINE:

Mid-Early Spring 1998
Planning research focus
Plan Multimedia course for summer '98 (communicate with Jason Kurth)
Design data gathering instrument (survey)
Review and field test instrument with 20 secondary students
Prepare and submit Human Subjects Document
Read many Qualitative Research Methods references
Keep journal accounts prior to qualitative research
Work with OPPTAG office
- Submit course description for Multimedia Mania
- Prepare introductory letters about instructors
- Create Interest Inventory for Multimedia Mania class
- Acquire labels to invite girls to participate in Multimedia Mania class
Fund scholarships as incentives for Multimedia Mania class
- Delta Kappa Gamma Upsilon Chapter ($200)
- Exxon Scholarship-Dr. Janet Sharp, ISU ($700)
- Professor Emeritus-anonymous donor to ISU foundation ($500)
- Lynn Glass Memorial Foundation Scholarship ($250)
MAIL labels to invite females to participate in Multimedia Mania class

Late Spring 1998
As registrants sign up for Multimedia Mania, mail survey/consent form
 Prepare focus group questions for summer '98
 Submit focus group questions to Human Subjects
 Arrange transportation to Ames Middle School
 Request sack lunches for MM students M-F
 Consult Ames Middle School staff on computer lab arrangements
 - Invite area high school females to participate
 - Check multimedia lab computer hardware, software, scanners (2)
 - Check out digital cameras
 Mail Interest Inventory to all MM participants
 Keep journal accounts prior to qualitative research

Early Summer 1998
Evaluate returned surveys of MM participants
Follow-up letters to non-responsive participants
Refine focus group questions
See Dr. Denise Schmidt about contacting 580 B students for summer course
Keep journal accounts prior to qualitative research

June 13, 1998
Parent group introductory meeting on Sunday
Explain the contents and expectation of the course
Introduce self, Jason Kurth, grad asst. and any El Ed 580 B students from ISU

June 14-19, 1998
Conduct focus groups 60-90 minutes over noon break (Thursday afternoon)
Organize 4 groups of #6-8 purposefully selected members
Participant-Observer during MM class (afternoons only)
Conduct student interviews each morning
Assign one hour homework each night:
  - Student participant journaling: prompts about MM class
  - Student participant journaling: prompts about technology use
  - Work on design of each individual multimedia project
Prepare for sharing projects in class on Friday and with parents on Saturday
  - Turn in homework journaling; inspiration designs, etc.
  - Turn in final projects on Mac Zip disks
  - Take the self-efficacy survey document (post test) once again

**June 20, 1998....10:00-11:00 am**
Students and their parents meet at the Ames Middle School computer lab
Students share final projects with parents at Saturday morning program at AMS
Be sure all have given a copy of final multimedia project to instructors

**Mid Summer 1998**
Analyze pre-post survey responses (Pre-conceived abilities and self-efficacy)
Evaluate final multimedia project according to rubric—problem-solving abilities
Train other raters to evaluate MM projects according to rubric—
Transcribe Focus Group Interviews
  - Enter data using FolioViews® software
Analyze participant journaling
  - Enter data using FolioViews® software
Determine data triangulation:
  * Student interviews
  * Participant Observation
  * Focus Groups
  * Student participant journaling and homework
  * Final multimedia projects
Begin analysis of themes and commonalities

**Fall 1998**
Finish typed transcriptions of all 20 taped interviews
Finish typed transcriptions of all 3 focus group interviews
Examine themes and commonalities
Continue “member check” with participants in MM group
Complete PhD preliminary exams and orals

**Winter and Spring 1999**
Complete dissertation proposal
Complete questions for communicating with MM participants
Consider honorariums for respondents to continue providing feedback
Complete writing, revision, and submission of dissertation research

**Summer 1999**
Make first deposit June 1, 1999
Get copies of research to all POS members
Defend dissertation at final orals June 30, 1999
Graduate August 7, 1999
APPENDIX P. COPYRIGHT PERMISSION
April 7, 1999

To whom it may concern:

I am writing my dissertation on using multimedia technology and problem solving to enhance the achievement of females using computer technology. In an effort to explain the potential of using multimedia technologies as tools for thinking and problem solving, I request permission to use two figures within my dissertation text.

Title of Book: Computers in the Classroom: Mindtools for Critical Thinking

Author: D. Janassen

© 1996

Specific reference: Figure 8.1 and 8.2 (see enclosed documents)

In addition, I need you to return the enclosed permission to quote/reproduce copyright material form with the appropriate signature and date indicated on the form.

Thank you for your attention to this matter. My work is to be published this summer. I hope for your prompt reply.

Sincerely,

Sally R. Beisser, Curriculum and Instruction
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APPENDIX Q. THEMES EMERGING FROM MULTIMEDIA STUDY
THEMES RESULTING FROM MULTIMEDIA STUDY (See Chapter 4)

Respondents: N=20 (5 males and 15 females) gifted adolescent students enrolled in a 30-hour residential summer course, 1998, Multimedia Mania.

Iowa State University
Beisser, S.R. ©1999

1. EARLY LIFE EXPERIENCES:
   Experiences of computer-savvy teenagers originate in their elementary years, whether in the school or in their homes.

2. PARENTAL INFLUENCE:
   Parents influence purposeful uses of computers, out of school experiences, and purchases of computer equipment even if they are not as computer literate as their children.

3. GENDER STEREOTYPICAL BEHAVIORS:
   A. Female students are more likely to incorporate text and visual images in multimedia projects, as compared to male use of sound, action images, and Internet hotlinks.

   B. Males were more likely to report technical information relative to their computer memory, speed of processor, size of hard drive, etc. while girls more frequently reported computer technology use or function or peripheral equipment.

   C. When asked what they wished they could do in school using computers, boys were more likely to request computer programming or CAD courses and advanced skill development.

   D. All students reportedly think females are as capable as males in becoming computer scientists, programmers, or engineers. However, proportionately fewer females believed they would major in computer related courses in college. ("We can, I can't" theory)

   E. Boys were more likely than girls to have a computer in their own bedroom at home.

   F. After completing the follow-up research series of questions, respondents were awarded a $20 stipend. Girls were more likely to spend their money on non-technical purchases.
4. **FEMALE CONFIDENCE LEVELS:**
Females who display greater levels of self-confidence using computer technology, have more experience using technology, associate with technology-using peers, and interact in game-related activity using computer software or Internet sites.

5. **FEMALE COMPETENCE LEVELS:**
Females holding perceptions of competence using multimedia-enhanced computer technology during the Multimedia Mania summer course, tended to select independent study topics related to science, sports, or controversial issues.

6. **MALE SELF-APPRAISAL:**
Male students reported greater levels of self-efficacy than females in selecting hardware and software, using multimedia-enhanced technology, and completing/presenting MM projects.

7. **NO GENDER DIFFERENCES ACCORDING TO STUDENTS:**
Students, when asked, insist there is virtually "no difference" in male-female use of computer technology among their teachers, peers, or parents. However, their interview narratives provide evidence to the contrary.

   A. Teachers
   B. Peers
   C. Parents
   D. Adults

8. **SELF-INSTRUCTION:**
A. Students, of either gender, are largely "self-taught" and find school-related computer courses relatively inadequate.

B. Boys enrolled more frequently in school-offered elective computer courses.

9. **CLASSROOM TEACHERS LACK COMPUTER SKILLS:**
Students view their classroom teachers as lacking competencies in acquiring computer skills, using skills in curriculum experiences, or facilitating student use of technology.

10. **RELEVANT SCHOOL EXPERIENCES WERE REPORTED:**
Not all school experiences were trivial. Some were meaningful to the students and connected to their curriculum.
11. MAC vs PC COMPUTER HARDWARE:
A majority of students used PCs at home for homework and leisure pursuits, while their schools generally had MACs installed for lab or classroom use.

12. CAREER GOALS USING TECHNOLOGY:
Students see a direct application of their computer skills and use of technologies in relation to their future career goals.

13. CAPACITY FOR PROBLEM-SOLVING:
A. Gifted students generally resist problem-solving instruction in relation to building multimedia-enhanced projects during the Multimedia Mania summer course instruction.

B. Students with a higher tolerance for metacognitive thought about their work or about problem-solving instruction produced electronic projects with greater depth, quality, or complexity according to the final evaluations of their MM projects.

14. COMPUTER AS A PROBLEM-SOLVING TOOL:
Students reported varying ways that computer technology can be a tool to help them with problem solving, but they also saw the computer as the problem needing solving.

15. CULTURE OF COMPUTER- USING ADOLESCENTS:
A. Use of abbreviated language and symbols punctuated student digital communication style, which while varying in access and frequency, had similar style with females using more symbols than males in their email communication.

B. Parents are not necessarily aware of or privileged to email or Internet activity of their children.

16. CHALLENGING RESPONDENTS:
Gifted adolescent learners can be rather challenging, opinionated students with whom to work and communicate.

17. TECHNOLOGY IN THE FUTURE:
Students see technology as a tool for their future and the future of the world in which they live.
RESPONDENT QUOTES FROM MULTIMEDIA RESEARCH STUDY

Respondents: N=20 (5 males and 15 females) gifted adolescent students enrolled in a 30-hour residential summer 1998 multimedia technology course called “Multimedia Mania.”

Iowa State University
Beisser, S.R. ©1999

1. EARLY LIFE EXPERIENCES:

Experiences of computer-savvy teenagers originate in their elementary years, whether in the school or in their homes.

“Probably my first experience with computers was when we'd just moved here and my dad brought a computer home that he has on loan from work. He works up at Farm Bureau in Des Moines. First time using it was probably was, Dad brought home a lot of educational games, math games. So, probably using those were my first experience. Now, we have two computers at home. One of them we got back when I was in fourth grade and it is so outdated now, that we were just going to give it to my grandpa, but now my little brother uses it. So, everything's changed in just three or four years. And now, like I just said, there's this new chip in just a couple of months. And if we would have waited, who knows what it will be in the future?” (Eric K., male, grade 9)

“And my first experience with a computer was probably when I was seven or around there and we had just got a new computer, and it was like top of the line then, and I was like playing solitaire and games like that on it and stuff.” (Chris K., male, grade 8)

“My first use was probably when I was 5 or somewhere around there. We had one of those, I don't even remember, Apples. It was tan I remember. We played games. One was called Layer Cake, and you had to choose how many layers you wanted on your cake and then you had to stack it. There were three piles and you had to stack it in the middle to see like how few steps you could use to stack the cake.” (Sarah B., female, grade 9)

“I guess the first experience I had with a computer was when my parents bought one. I was probably about 5 or 6 and they bought educational games again, and that's probably what I used first.” (Laura, female, grade 9)

“My first experience with a computer was in my mom's classroom 'cause she's a teacher and I just went to her classroom. Her little freshmen, what she was teaching, were playing and I just wanted to be like the big kids, so I pressed and typed a whole bunch of buttons and froze up the computer. And my mom just keeps warning me about how she doesn't want me to freeze up the computer again. She tells me that story all the time, so that's certainly my first computer use.” (Jessica, female, grade 9)

“I think my first computer use would've been when my parents got this Apple IIe, and it was like, I think they got me this Big Bird Sesame Street game thing. We don't have it anymore, but that's what I remember playing first. I don't remember what it did, but I know I played it. I got that computer in my room because they don't use it anymore.” (Jackie, female, grade 9)
“I have my own web page, but I don’t like to give out the address because I haven’t updated for a few years. It was probably sixth grade the last time I updated it.” (Liz B., female, grade 9)

“I have no idea the first time I used a computer. But, I know the elementary school I attended had computers, and my first conscious memory, I guess you could say, was from like 4th grade. But, I know that I've been using computers there since I was 6 or 7. And, I probably remember stuff from 4th grade better because that's the year we got a computer at home. They were Apples. They were really nice Apples. It was before Apple and Mac had merged, but it wasn’t like the really old ones that had the green screens. They were nice Apples; I guess 5 years old at the time or something. Surprisingly, they were better than the ones I got in Junior high, and mostly for typing up reports and drawing pictures. Once we had to draw a star or some type of design, and we had to have it go through random colors or stuff.” (Rachael, female, grade 10)

“I don’t have a specific earliest memory, but ever since kindergarten we used the computers in the computer lab.” (Alicia, female, grade 9)

2. PARENTAL INFLUENCE:

| Parents influence purposeful uses of computers, out of school experiences, and purchases of computer equipment even if they are not as computer literate as their children. |

DAD:

“Sometimes my dad will try to teach me and my sister how to use software that he brings home from work. He will sometimes do presentations for companies. He is part of Toastmaster. He gives speeches and presentations and stuff. So, every once and a while he will bring home a laptop for work and he does his presentations.” (Eric B., male, grade 9)

“A guy friend called me and told me about Gemstone3®. I started a two week free trial and now I have to pay. I bring my dad money and he just uses his credit card to pay for it. It’s ten dollars a month for just one character. For $20 a month you can have as many as you want, so it’s not that bad.” (Liz B., female, grade 9)

“I mean, if I couldn’t find something, he [my dad] would show me how to use search engines and where to go to put something on my papers. I mean, just little stuff like that. They [the teachers] don’t teach it [PowerPoint®]. I learned it from my mom because she uses it all the time. She works for Pioneer® and she does presentations a lot and stuff.” (Alli, female, grade 9)

“My dad is the one who decides what is boughten (sic) but when we get things I get to help in the decision.” (Chris K., male, grade 9)

“My dad usually makes the software decisions. He knows what will run on our computer and how well it will do it. He's the one who suggested getting a Pentium II for the Gateway.” (Kristen P., female, grade 9)

MOM:
"In my house, my mom is in charge of computer purchases in our house. I also help out a lot though. My dad and brother use them, but don’t really know a lot about computers other than how to get it to do what they want.” (Kate P., female, grade 9)

“Well, I don’t have internet at home, but I have an e-mail account. My mom only lets me use it once a week because it costs to call down to the thing. A couple of days ago, I ordered some stuff over the Internet, and I will hopefully get it in a couple of days.” (Eric K., male, grade 9)

“Well, actually, my mom has set up a web page, which I can have one, but it is a link from hers, because she is a traveling consultant for computer statistics and her company is Zetamind, which is also her e-mail address.” (Jake K., male, grade 9)

“Usually it’s my mom who decides on what we plan to buy with regard to computers & computer equipment. We have four computers—a Gateway 2000, a Texas Instruments, a Zenith Data Systems, and an old Apple which we don’t use very much anymore.” (Liz B., grade 9)

“It is mostly my mom and I. My parents buy a lot of educational and recreational software for me. We recently decided to get a new computer. I wanted to get a Macintosh G3, but my mom decided upon a simple iMac instead. A lot of times I will decide upon what we need, such as a new modem because ours is dead, and tell my parents to order it, because you have to be over 18, but my parents procrastinate and forget, so our modem died a year ago we have yet to order a new one.” (Rachael, female, grade 10)

“Where did I first learn HyperStudio? I think my mom told me about it.” (Jessica, female, grade 9)

“*How did you learn how to use the Internet? Messing around. My mom told me about some search engines.

*So your mom taught you?
Not too much. I kinda taught her in what way. I showed her stuff she didn’t know.” (Kelsey, female, grade 8)

“My mom is the one that introduced me to technology and I probably wouldn’t have the type of background I have without her. Everytime she got a new program or saw something new she’s always, ‘Sarah, come here. I want you to see this.’ And I would learn how to use it. And my dad didn’t really get into technology until just this year because his business is updating and getting a new business computer program.” (Sarah, female, grade 9)

BOTH:
“My parents are both computer illiterate. My dad is a farmer and doesn’t care, but my mom is interested in learning about the computer.” (Alicia, female, grade 9)

“My dad and mom usually do all the decision making about the computer stuff. However it becomes a huge dispute between my brothers and I in who is going to decide what games or programs were going to buy!” (Jessica L, female, grade 9)

“At my house, My parents decide what computer & equipment to buy. We have a Gateway with Windows ‘98.” (Kelsey E, female, grade 9)
"In our house my parents decided what kind of computer was going to be purchased. We all decide what kind of software we want and can purchase it ourselves if our parents don't want to buy it for us. At our house we use a Gateway 2000 with a Pentium II processor. We also have a 486 Leading Edge. My mom has a Compaq laptop for work that we use at home." (Nicole R., female, grade 9)

“When it comes to basic software, it’s usually my parents since I really don’t have any programs that I MUST have, I just use what my parents have.” (Alli R., female, grade 9)

STUDENTS INFLUENCING PARENTS:

“At home we have not purchased any new equipment, I am still helping my parents learn how to use what we have. My school, however, has bought new equipment since last year. They bought a couple of iMacs for our new computer lab and many laptop computers as well. Our school also purchased a zip drive, but students are not allowed to use it even if they have their own zip disk.” (Alicia R., female, grade 9)

“I am the deciding factor when it comes to games. : )” (Alli R., female, grade 9)

“If she needs help, then my mom asks me about it.” (Stacia, female, grade 8)

“At lot of the time he [dad] will ask me if I think that the product looks good.” (Laura, female, grade 9)

“Neither my mom or dad want to be on the computer. They have us check their e-mail and just print theirs off. But they do it when they have to.” (Mary, female, grade 8)

“I definitely try to teach my mom that. I mean, I’m not saying she’s not smart. But she just wouldn’t get it. Because they’re just not used to it.” (Justin, male, grade 10)

“I use the computer much more than my dad. And I think I know more than him, too. Because one time I was just—I think it was last summer—I was just messing around on the computer. I built a web page and called him up at work and asked him if he had access to the Internet. That way he could go look at it.” (Chris K., male, grade 8)

FINANCIAL CONSIDERATIONS:

“Whoever is paying decides what to buy, if my parents are buying something I usually help them decide what would be best, and if I’m buying then I just have to OK it with them first.” (Melisa, female, grade 10)

“Actually our financial situation decides what we can buy for home. My dad also needs to see relevance in buying different things, and he isn’t very computer literate so it’s hard to convince him.” (Alicia R., female, grade 9)

3. GENDER STEREOTYPICAL BEHAVIORS:

A. Female students are more likely to incorporate text and visual images in multimedia projects, as compared to male use of sound, action images, and Internet hotlinks or equipment to build their electronic projects.
"I think that boys are more likely to use scanners. I use it [computer] for like downloading something in my project. If I'm having problems sometimes I'll e-mail my problem to the person who put up the site to see if they can help me. Which does work. And, for a time I was a part of a group of people on the Internet based on a series of books I liked. Like a role playing kind of thing. So, I used e-mail a lot then to talk to people over there or send stuff." (Eric B., male, grade 9)

"I think some of the projects that we have, the girls, I'm not saying this to put down guys or anything, but the girls' projects, I actually have found, to me, to be a little bit more appealing. I look to the person next to me and the other person next to me, and I'll like one over the other, and it happens to be the girl's over the guy's. Not because of the subject, I personally, like the guy's subject actually better, but his design on his project and the way he set it up, it just seemed it was all action, pictures, and sound, and it wasn't much else added to it from him. But on her's she had maybe one or two pictures imported and the rest were made by her. She had a lot more writing, and was just a little bit more interesting." (Jessica, female, grade 9)

"But, one of the girls sitting next to me is an on-line game, and it's a text-based game, so she can't find the graphics or anything. But, I think I like her site better than mine that has a lot of graphics just by the way it's set up." (Laura, female, grade 9)

"Well, in a project like this, you need information so graphics are a nice addition, but you don't want them to over power everything else. You need action." (Eric B., male, grade 9)

"You see a lot of—I don't know—this sounds really sexist and stereotypical, but a lot of people I've met... it's mostly the guys that are talking about how they can make web pages. And I don't think that they invite girls to make web pages." (Kristen, female, grade 9)

"And guys do a lot more programming and stuff and girls just like 'watch'.” (Alli, female, grade 9) “Guys are expected to do that.” (Jake, male, grade 9)

"*It sounds like you understand how to work with that pretty well. Why did you choose Hyperstudio over Empower?

Well, for one reason, the pictures I wanted to use on it were gifs, and the Empower wouldn't let me use gifs. At first, I thought Empower looked a lot better, but I don't really...I like the way Hyperstudio works much better than the buttons and stuff on the Empower. It's just easier to make and stuff like that." (Chris K., male, grade 8)

"I am going to go back to this marine biology thing. Possibly in... well... in organizing information. When I find out information, I am not going to be able to remember all of it. Like when I had all those crashes, I couldn't—I'm like, what was this going to, what was this linked to, this was a link, but where was it going? And I couldn’t remember it. But this, if I didn't have these problems, I would probably look on it as a bigger help.” (Jackie, female, grade 9)

B. Males were more likely to report technical information relative to their computer memory, speed of processor, size of hard drive, etc. while girls more frequently reported computer technology use or function or peripheral equipment.

BOYS:
“Yeah, we just got a new Gateway. We bought it and then they came out with the 400 MHz chip right after we bought it. We got the 300. We could probably get an overdrive if the make one for it. I’ve got a lot of magazines that talk about increasing the power of the card. Like buying stuff and putting it in them.” (Eric K., male, grade 9)

“I have not bought any new software but i would like to. Some software that i would like to use are hyper studio and some graphic and web making tools. Some hard ware i would like to use are dvd rom drive, click drive, and 3d graphics card. i'd like some web design software like microsoft front page and adobe page maker. In regards to graphics i would want a gif animator. At home right now i use a dell 200 MHz computer with cd rom, printer, 17" monitor, 33.6 modem and 4 gig hard drive. Any questions feel free to e-mail me.” (Chris K., male, grade 8)

“I have not bought anything personally except a game demo CD, but as a family we have acquired quite a bit. First off, we have a brand new Gateway computer with Windows 98. On our old computer, we have an AOL account (although we’ve had it for a while). On the new one, we are using up all of our ‘x free hours’ cds.” (Eric B., male, grade 9)

GIRLS:

“We have a Macintosh Performa 550 that came with a keyboard made in Malaysia. Our printer is a Stylewriter 2. Our modem, which has died, is a Global Village Teleport Bronze. I want to get a Global Village Teleport Gold modem because it is the type of modem most similar to the dead modem we have. The Teleport Bronze isn’t made anymore.” (Rachel S., female, grade 10)

“I learned to use Adobe Photoshop for the Macintosh and had a lot of fun scanning and altering photographs. It has also helped me recently with school-related projects, because the program I use now is very similar. I haven’t had much time to experiment with any other new software, other than games of course. At home I use a Gateway P5-166 XL and at school some very old Macs. Adios!” (Alli, female, grade 9)

“Recently we got a new computer at home, our new computer is top of the line and also came with lots of software. At school we are still using old Mac’s, but we’re also using Gateways abit more. We also just got some new video editing equipment (its a Casablanca system, I think). We are also getting upgrades to our Adobe PageMill software.” (Melisa, female, grade 10)

“My family purchased a new computer. It was very similar to the last one we had, except it had more memory and was faster. It is a Packard Bell Platinum 7800. We also purchased a lot of new software, such as games and educational programs. Last fall, we bought a new printer that is a copier/scanner/printer and fax machine in one. In school, I have not really noticed a change in our technology since last summer. Last spring, however, we got brand new computers. We now have ICN, and new IBM computers all hooked up to a SchoolVista network. We have several digital cameras.” (Kate P., female, grade 9)

“My family bought a digital camera since last summer. We also bought a lot of new software. I have worked more with scanners, though. At home I have 2 computers, the one that I use the most is a Dell with a color printer. I also use a Nikon digital camera at home. It has an 8 MB disk inside it. At school we use Macs and scanners.” (Laura M., female, grade 9)
"I have not bought any new computer software or hardware, but my parents bought me a computer (PIIpro) of my own and I use it every day. I have also received several games (educational and just for fun) and Corel Word Perfect 8. I've got a joystick, speakers, a microphone, and everything else that generally comes with a computer. Every day when I am on the computer, I usually play MUDs or research online for homework. I use online to talk to my friends through e-mail, IM, and in the multiplayer games I play. I hope my response is useful to you." (Elizabeth B., female, grade 9)

C. When asked what they wished they could do in school using computers, boys were more likely to request computer programming or CAD courses and advanced skill development.

"At school, I took CAD class last semester and am taking advanced CAD this semester. We use a program called Design Post Drafting (I think). Our teacher is also trying to get running a program to control a lathe, but is still working out some bugs. I've been downloading some sound and movie clips, and also some emulators (Super Nintendo and Game Boy) with great games. That's all I can think of for now." (Eric B., male, grade 9)

"I wish we could have some web design software at school like Microsoft Front Page and Adobe Page Maker. I regards to graphics I would want a gif animator." (Chris K., male, grade 9)

"In school, I wish we could have more advanced computer classes. Right now, the only computer classes that we have that I am aware of are: 8th grade keyboarding (required); computer history (required); and Computer Business Applications. I would like to see a class that we could do a lot of work with the digital cameras, Hyperstudio, and scanning. The classes we have offered right now, are very outdated, and the first two are taken in the Mac lab, in which the computers are about 10-12 years old, and not capable of doing much. Some of my classmates that don't have computers at home only get the opportunity here at school." (Kate P., female, grade 9)

"Well, there's a class at Jefferson called Global Geography, and my friend used to say that we should go to the computer lab and do a presentation on the computer. And we did Power Point and so I was like, It's a lot easier to do it on a presentation on the computer." (Justin, male, grade 10)

"I took a CAD class." (Justin, male, grade 10)

"I took Astronomy, Chemistry, and Radio Personality at College for Kids." (Chris K., male, grade 8)

*Are any of your girlfriends taking computer classes or anything like this this summer?  
"Not that I know of. They don't talk to me about it." (Kristen, female, grade 9)

**Don't you think you use problem solving skills when you have those technical problems? Actually, I just say, 'I need help.' That's what I did. I just said, 'I need help.'" (Jackie, female, grade 9)

D. All students reportedly think females are as capable as males in becoming computer scientists, programmers, or engineers. However, proportionately fewer females believed they would major in computer related courses in college. (**"We can, I can't"** theory)
"I believe that women are capable of anything and everything that guys are...as long as they know what they are doing and are properly trained!!" (Stacia, female, grade 8) Stacia wants to work with horses when she grows up.

"Females are as capable as males to become computer scientists, programmers, or engineers. I think that females are just as capable of doing those jobs as males." (Laura, female, grade 9) Laura, however, wants to become a historian.

"Females are as capable as males to become computer scientists, programmers, or engineers." (Kate, female, grade 9) Kate wants to become an accountant or an actuary.

"Heck yes!! I KNOW I am just as computer literate as many of my closest (and not so close) guy friends...and if I really wanted to I could learn anything about computers that I wished. Give me three hours with my friend Mitch and I could probably take your computer apart and put it back together working faster and more efficiently" (sic). (Alli, female, grade 9) Alli, however, wants to become a USAMID microbiologist.

"Females are definately (sic) capable of being whatever they want to be on the computer. Most typists are female, yet programmers are generally male. If females can type just as fast, and we are certainly intellectually capable of programming, why don't we? I plan to become one if I get the proper education. I want to go to Grinnell. The small town atmosphere seems like it would be a good change. And it is a renowned school, with high standards." (Liz B., female, grade 9) Liz wants to become a computer programmer and hopes to attend a small private competitive Midwest college.

"I really do believe that females are just as capable as males to become computer scientists, etc. They are just as capable, but at the moment, maybe not as qualified. All of the attention has been directed towards males in our society, so the skill lies with the males. That's not to say there aren't females out there who are more qualified than males. If a study were conducted on all of the computer scientists, the few women in the classes could be better at what they're doing just because they've had to work hard enough to get where they are. They may have the ability to work harder than the men in the class." (Sarah B., female, grade 9)

"I believe we are [equally capable]. This is a time where women are just finishing shaking the bonds from long ago that forbid them to do anything...vote, work, do anything outside of housework. Now, everywhere you go, you see the almighty slogan, "Girl power" or "Women rule" promoting women having the upper hand over men for the first time. And, pardon my french, but in my opinion, I think it kicks ass! GO ELIZABETH DOLE!!" (Kristen, female, grade 9)

"I think that women are as capable, if not more capable then males. Women are generally more patient and calm then men, which can be a major advantage in anything dealing with computers." (Melisa, female, grade 10)

"Yes I do because I believe if you set your mind to something and work real hard towards achieving your goal, you can do it no matter what it is." (Alicia R., female, grade 9)

In fact, girls were more likely to state tentative comments at the end of their remarks, such as "Hope this is of use! Until next time!" (Jessica L., female, grade 9)

"I hope my response is useful to you." (Liz B., female)
"Thanx for lettin’ me be a part of this! I guess I’ll talk to u later or something. Buh bye!!! (Alli, female, grade 9)

"I hope this works for you!" (Kate, female, grade 9)

"I guess that’s my last set of questions. It’s been nice talking to you. Love and luck always.” (“Betty Sue,” female, grade 9)

Boys were more likely to suggest I consult THEM. “Any questions feel free to e-mail me.” (Chris K., male, grade 8)

While there were several females who requested summaries of the research findings, not one male asked for any follow-up data.

E. Boys were more likely than girls to have a computer in their own bedroom at home.

"I have a computer at home in my own bedroom at home! Yes!” (Jake, male, grade 9)
So did three other males in the study.

“Nope, I don’t have a computer in your own bedroom at home, but I really want to get one though!” (Melisa, female, grade 10)

“No I do not. I wish I did, but I can’t afford it.” (Alicia R., female, grade 9)

“I don’t have a computer in my own bedroom at home? Unfortunately...no.” (Stacia, female, grade 8)

“Ha, I wish!!! Actually, there are two reasons I don’t have one in my own room. The first is that my parents don’t want me to lock myself in my room and not come out for hours and hours because I’m on the computer (they’d rather I do it in the basement where our family computer is...hehe). The other reason is that any computer I got now would be the one I take to college, and if I get it now I know it will be incredibly obsolete in the next three years. So I’m just gonna wait. Besides, just having the basement computer isn’t too bad, just I didn’t have to wait for everyone else all the time!!:)” (Alli, female, grade 9)

“Yes, I have a computer in my bedroom but I hardly ever use it. In our family, it’s referred to as, "The Fossil". It was top of the line for about two weeks. Yes, it’s a '92 IBM PS2 and a piece of crap. As the ad company trying a sell this piece of crap would say, "Fully equipped with Windows 3.1 and some MEgabytes of ram. Hell, my company’s too damn lazy to find out how much, but we know it’s nowhere near a gig of memory!! BUY IT!!" Yep. I sure love my computer.” (Kristen, female, grade 9)

“I don’t have a computer in my room, but I have my own computer down the hall.” (Liz B. female, grade 9)

“I do have a computer in my bedroom. It’s an i Mac.” (Sarah B., female, grade 9)

F. After completing the follow-up research series of questions, respondents were awarded a $20 stipend. Girls were more likely to spend their money on non-technical purchases.

“I will probably spend it on books or food” (Kristen, female, grade 9)
"I will probably buy a new cd. I have a limited supply of good cds. You can never have too many." (Liz, female, grade 9)

"Oh, I will spend it on my new dog, or I'll put it in savings, or I may buy a new CD...I've wanted Fatboy Slim for a long time. I also have a dress I wanted to get that I could put this towards or I could buy my Dad's birthday present." (Alli, female, grade 9)

"I will probably save it, because my parents are making me pay for all of a car, and I am turning 16 in September." (Kate, female, grade 9)

"Software." (Eric B., male, grade 9)

"RGP games." (Jake, male, grade 9)

$20 on? I'm not sure, I will probably save it to pay for a camp that I want to go to this summer in New Jersey." (Alicia R., female, grade 9)

What will you spend your $20 on? "Probably presents for my mom for mother's day." (Rachel, female, grade 10)

I'm getting dvds. (Justin, male, grade 10)

4. FEMALE CONFIDENCE LEVELS:

Females who display greater levels of self-confidence using computer technology, have more experience using technology, associate with technology-using peers, and interact in game-related activity using computer software or Internet sites.

"It makes a difference for females, to have experience [with technology]." (Alicia, female, grade 9)

"I think it would be a ten. I have enjoyed it so much and I have learned a lot. I have learned a whole new way of presenting material and it was really fun. I got to know a lot of people and the instructor was great and his assistants and the speakers that came in. Just learning all day. So if you are really intellectual, you know, doing something this summer, "I am taking a class at Iowa State—everybody's 'Wow!'" (giggle) (Sarah, female, grade 9)

"Uh...not really. I do the email thing, talk to my friends (on AOL Instant Messenger...I don't do the chat room thing!), research, and sometimes just surf. Mostly when I'm not on the 'net to check my mail I'm diggin one of my buds' web sites. A lot of my friends have them and update them regularly. My friend Staci has a link to a page of dancing chickens!!!! hehehe..." (Alli, female, grade 9)

"Well, I think I do pretty much normal stuff on the net. I talk to friends (what most of my friends that are girls do) and I play text based multi player games (what most of my guy friends do). Nothing really out of ordinary. (Liz, female, grade 9)

5. FEMALE COMPETENCE LEVELS:

Females holding perceptions of competence using multimedia-enhanced computer technology during the Multimedia Mania summer course, tended to select independent study topics related to science, sports, or controversial issues.
"We bought a new PC last May: a Gateway G6-300 with 300 MHz processor, 64 MB RAM, DVD/II ROM drive and 3.5" floppy drive and a color printer: HP Deskjet 722C. This month we got a flatbed scanner, UMax Astra 1220P. That's the only hardware. For new software, for Christmas I got Star Trek starship creator and Cydonia. I like Cydonia, especially learning an alien language. For my birthday Feb. 7, I got Cakewalk Home Studio 7 (version 8 is coming) and almost every chance I get, I use it to write music. I love the music program so much I haven't had a chance to try my "Learn to Speak Spanish." I've also tried my brother's Star Wars Droidworks (to build robots and put them through missions.) Since last summer at school I have newly started to use the program SciPlus, a problem-solving science program."

(Julie L., female, grade 9)

"I am going to work at the United States Army Medical Institute of Infectious Diseases (USAMIID), actually. I read a book called the Hot Zone that I was really, really interested in. And I wanted to work with virus and Ebola. It sound kind of gruesome, but I like stuff like that. And I used the Internet and I went to USAMIID's homepage and got to explore what kinds of degrees and stuff I need to work there and stuff." (Ali, female, grade 9)

"My family hasn't bought any new computer equipment, except for new ink cartridges every few months. At home I use Clarisworks and bank street writer a lot. At school I use Microsoft word. First semester, I took a class called 'CAD and communications.' I found this class to be a lot of fun. I used PowerPoint to create a presentation about my school's history. It took, literally (sic), months of research, but I enjoyed finding out my school's past. The principal saw my presentation and now I am designing the history section of my school's webpage. I hope to have it finished by the end of the school year. The program I am using is Microsoft Front Page. Even though the program claims you don't have to know HTML, I am writing most of the webpage out in HTML because I hate wizards. The program has taken a lot of figuring out. I only work on the webpage two days a week for 55 minutes because of my hectic school schedule. Fourth quarter, I plan to will be working on the webpage three days a week because I won't have to work around health class anymore. If I find time, I will send you a copy of my presentation - and the webpage when I finish it." (Rachael S., female, grade 10)

"I just kind of play around with it [the computer]. Usually I would do fine on what I was supposed to do. But I would find all this other nifty stuff. So I have fun with that. And then at Clark College, which is near my school, I do the "Surf the Net" class, where I learned HTML and how to make web pages and all that wonderful stuff. In there, they also did stuff with Hyperstudio." (Racheal, female, grade 10)

"My project is about wolves. And I picked this topic just because I have an interest in wolves. I'm making it informational just for people who don't know much about wolves. It's also sort of persuasive. I have a clip about it, shows a person dragging a wolf into the back of a truck and killing it. And just saying, "Don't let this happen again." I'm using Empower for my multimedia presentation and I have never used that before. I hadn't even heard about it before this class. I like it a lot." (Sarah, female, grade 9)

Female topics: Cardinal Baseball, Chicago Bulls Basketball, Dolphins, Mars, Constellations, Neonatology. Unusual topics such as Earthly Elementals, Cats in Outer Space. Issues of controversy such as unfair stereotypes of wolves or online game activities such as Gemstone3.
6. MALE SELF-APPRAISAL:
Male students reported greater levels of self-efficacy than females in selecting hardware and software, using multimedia-enhanced technology, and completing/presenting MM projects.

<table>
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<th>Minimum Score</th>
<th>Maximum Score</th>
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Table X. Wilcoxon Signed Ranks Test for Student Pretest and Posttest

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<td>36801.50</td>
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<tr>
<td>Female</td>
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<td>235.88</td>
<td>88448.50</td>
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<tr>
<td>Total</td>
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Table X. Whitney-Mann Test Statistics\* for Gender Difference

<table>
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<tr>
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<th>Wilcoxon W.</th>
<th>Asymp. Sig. (2-tailed)</th>
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</thead>
<tbody>
<tr>
<td>Difference between posttest - and pretest</td>
<td>17948.500</td>
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<td>-4.119</td>
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</table>

a. Grouping Variable: Gender

7. NO GENDER DIFFERENCES ACCORDING TO STUDENTS:
Students, when asked, insist there is virtually "no difference" in male-female use of computer technology among their teachers, peers, or parents. However, their interview narratives provide evidence to the contrary.
A. Teachers

FEMALES:

"My female teachers use their computers mostly to type up and enter grades. Also, they use it to print up overheads and worksheets. Some teachers, like Ms. Threefourtyfive, have E-Mail accounts and occasionally check them when we are working on something." (Kristen, female, grade 9)

"My geometry teacher uses the computer for grades and for attendance. My computer teacher uses the computer to teach the class. My Spanish teacher uses the computer for grades and attendance. My cultural geography teacher uses the computer for grades and attendance. My English nine teacher also uses the computer for grades and attendance." (Jackie J., female, grade 9)

"I have three female teachers in my schedule at school right now. Mrs. V, my Developing Citizenship teacher, uses the computer for word-processing—things like study guides and tests—and also for grades. I'm sure she also has QuickMail, the in-school email between faculty. Ms. B, my Spanish II teacher, uses the computer for grades and QuickMail. She may use it for other things but that's what I see her using it for. Mrs. B, my Algebra II teacher, uses the computer for math stuff. She hooks it up to the TV and uses some program that is like a really advanced graphing calculator. She also uses the computer for grades and QuickMail." (Alli R., female, grade 9)

"Most female teachers use computers at my school to type progress reports and some use them for lessons. For example, my geography teacher, Miss Jones, gave us all time during class to use the National Geographic CD-ROMs to look up information on a country we had to do a project on. Also, last year, through a class called World in Motion we used the computers to put together a PowerPoint presentation. Our computer teacher, Mrs. Lone, was the main person to help with that project." (Mary G., female, grade 8)

"Most of my female teachers—chorus, journalism, math, Spanish, language arts/social studies, also my former sign language teacher, who also teaches math and science—use the computer for grades and word-processing, although my math teacher sometimes uses it for fooling around, and the computer-lab teacher also uses it for teaching, multimedia, and Internet." (Julie L., female, grade 9)

"Most female teachers in my school basically use the computers in our school for grades and word-processing. They use the computers to type up worksheets, tests, etc." (Kate P., female, grade 9)

"Most of my female teachers use computers somehow in their job. My "IMPACT: Fine Arts" (this class is a one semester art class required for graduation) teacher, Mrs. Johnson, uses the classroom's Gateway Destination every day to present vocabulary and many other things to the class. She also prints out worksheets, overheads, and tests off her computer at home. My P.E. teacher does not use computers for anything that I know of. My Spanish III teacher (Mrs. Berger) prints out worksheets, overheads, tests, and grade up-dates off her computer. My English 9 Accelerated teacher, Mrs. Burns, doesn't use her computer for anything that I know of, but she lets the students use it for presentations when we need it." (Liz B., female, grade 9)
"My geometry teacher, Mrs. Blush, uses the computer to print off our grades on a spreadsheet. We have numbers representing our names, and we can check how we're doing in the class about once every two weeks. We've never gotten to use a software program to help us design geometric figures, but I've heard we might be able to in the future. My Spanish teacher, Mrs. Chica, uses a program called Ya Vers to review before a test. We use the computers in that class about once a month. My World Studies teacher, Mrs. Globe, frequently types up a quick outline of the current chapter we're on, or uses the overhead and types out notes on a transparency and talks about them. When we have any projects, she takes us to the Media Center and gives us about three days of research on the internet. My English teacher, Ms. Blonde, uses the computer to print out notes on a transparency, or prints out reading evaluation sheets, or written assignments.” (Sarah B., female, grade 9)

“I only have one female teacher, that was my Spanish teacher. She was a traveling teacher. She used a computer for grades and stuff. But I know in seventh grade my teachers mainly used it for typing up letters they wanted to send home for parents or for grades and communication.” (Alli, female, grade 9)

“We used spreadsheets, databases, different presentation software for the Science Fair. My male teachers were English and Social Studies and they didn't really use computers. I tend to think that females use them more for organization.” (Stacia, female, grade 8)

“My Algebra/Science [female] teacher just kind of...she's well...she uses it mainly for grades, I think. In our room? We have three computers in our room. Two of them are hooked up to the Internet and the other one is for typing programs, like Claris Works and stuff. But my Language Arts/Social Studies [female] teacher is, well...she uses them [computers] as little as possible. She uses them for grades, but otherwise as little as possible.” (Jackie, female, grade 9)

“In sixth grade there was a male and a female teacher. The male used the computer more. He used it more for his classes to present [information]. He would get stuff off the Internet to teach us or for his research. But he didn't teach us how to use the Internet.” (Kelsey, female, grade 8)

“We did “Save Our Streams” for a project. We e-mailed something to another class, like stuff about our state and our water shed, and they had to figure it out and post it on the Internet and stuff like that.
*And that was a male teacher...
Female.
*That was female? Ohhh. You didn’t tell me that.
She was the Science teacher.
*So it sounds like the females that teach Language Arts did not use the Internet, but the females teachers that taught Science did.” (Kelsey, female, grade 8)

MALE TEACHERS:
“My Biology teacher Mr. Maguire uses his computer every day in class. He keeps an up to date record of our grades in Excel. He occasionally prints out tests and worksheets from his computer but usually we use the ones that came with the book. Although he usually writes them with a felt tip marker, sometimes he will type up our notes for an overhead sheet. My Electronics teacher, Mr. Petersen, (although he rarely remembers spellcheck,) uses his computer to make almost all of our worksheets and the overheads for our notes and our test papers. My choir teacher (Mr. Slotsky) uses his to keep track of money in our accounts for a trip to Colorado and fundraiser money.” (Liz B., female, grade 9)
"My science teacher, Mr. Gigantus-baldus, doesn't like the computer at all. He uses it to print out little sheets of paper that inform us of what we'll be doing that day, but he even tells us how he's never going to let the computer "over-take" him. The other teacher, on the other hand, has a home page where the students can enter their special number and get their grade. They can also find out about what they did in class that day. My science teacher is my only male teacher." (Sarah B., female, grade 9)

"The male teachers in my school also use the computers but I see them using them for different reasons. The male teachers often play games on them and surf the internet when a class discussion is over with. I have 2 male teachers, and one of them is rarely seen using the computer, and the other one quite frequently does, to play games, or surf the net for sports sites, and to enter statistics from the game the night before." (Kate P., female, grade 9)

"Male teachers aren't much different. My Science teacher also gives us our grades on computer printouts and I see him playing games on the computer, too. My Soc. Studies teacher looks up lots of basketball statistics on the internet." (Kelsey, female, grade 8)

"My earth science teacher uses the computer for grades, attendance, and sometimes for presentations. My health teacher uses the computer for grades and attendance, also for sending tasteless jokes to other teachers." (Jackie J., female, grade 9)

"At my school the female teachers seem to use the computers for presenting information, giving grades, scanning things, and Internet research. For example in my social studies/English class Ms. T uses the computer to show us our grades." (Laura, female, grade 9)

"My male teachers use computers for basically the same things as my female teachers. They figure grades on a special software, print out plenty of worksheets (there are times I wish their computer (sic) would crash), and sometimes check their E-Mail." (Kristen, female, grade 9)

"All the teachers use e-mail and they just send it back and forth to each other and informing each other of the changes they are making. Instead of having to go and tell each other, they can do it a lot faster." (Eric K., male, grade 9)

"I have three male teachers in my schedule right now. Mr. FG, my Ancient World Civilizations and Humanities teacher, uses the computer for word-processing tests and for recording grades. Mr. F, my Elements of Chemistry and Physics teacher, uses the computer for word processing our tests and also some class handouts and grades. Mr. V, my Combined Advanced English 10 and Speech teacher, uses the computer for many class handouts, tests, answer sheets, and grades. Though I don't have him this year, Mr. S, one of my more technically inclined teachers who also teaches a computer engineering course, uses them also to give presentations and for internet research." (Alli R., female, grade 9)

"Most of my teachers don't use a lot of e-mail. And I know, at least my Science teacher—he's pretty cool—he's down at Central. He uses it to give presentations to like...it's an easier way to give lectures, because you get bored with lectures. We take notes better if we've got visual stuff. So he'll like scan pictures from the book in and then like, take the information. So, it's a lot funner." (Alli, female, grade 9)

"Of the computer teachers I've had, they've all been guys. But, all my other teachers have used technology in some way." (Laura, female, grade 9)
“With regard to just skills and interests, it’s male dominated. It’s the male teachers who have the skills.” (Melisa, female, grade 10)

“Well, it seems like the guys [teachers] use it more for class time. And some of the females [teachers] use it for like tests and stuff, but not as much in class. Or, for example, in Science, we collected weather data every day, and we got that off of the Internet. For literature we use it a lot. One of the female teachers that uses it [the Internet] a lot in her class. We type in her class a lot of the time.” (Alicia, female, grade 9)

*Well, is there any female who knows a lot about computers?*

“You don’t hear them [female teachers] talking about computers and stuff, but since they are actually teaching about the computers, you hear them talking about what they know. My computer/library teacher is a guy and he knows a lot about computers” (Chris K., male, grade 8)

“No, they [teachers] used the computer a lot for grades, seating charts, worksheets, e-mail and all that stuff.” (Kristin, female, grade 9)

**B. Peers**

“I’ve noticed that just in this class that girls kind of tend to talk to their computers more than guys. I’m serious, I really am. I’ve noticed that the people sitting around me I only hear girls talking to computers. Most guys in here don’t generally talk to their computers.” (Jackie, female, grade 9)

“I’ve given a cuss word, but nothing other than that.” (Eric B., grade 9)

“I’ve threatened it a couple of times.” (Chris K., male, grade 8)

“Most of the games on the Internet are more violent-centered.” (Jackie, female, grade 9)

“There’s this one temple game or something, where the characters are this female who is like half naked running through the jungle or something.” (Rachael, female, grade 10)

“And another thing that probably effects that is that in a lot of the games there's two types of women. The ones who are supposed to appeal to the males or the ones that die.” (Eric B., grade 9)

“I see people mostly the same in finding information. Maybe different topics they look up. You know, girls some go in there and they look up stuff they are interested in and guys go in there to look up cars and just different stuff people are interested in. I guess, it depends on the individual.” (Eric K., male, grade 9)

“I really don’t think there’s a difference in why they [males/females] use computers. It’s an information thing. Everybody will go to [the Internet] and type in the same kind of words. There is a difference in how people use computers. ...like on the Internet when you are in a chat room, half the girls in the chat rooms are guys. Well, we were in the chat room and I was talking to someone named Carla, and my friend leaned over and said, ‘You know, it’s probably a guy.’ And it probably was.” (Jake K., male, grade 9)

“I think most of the girls tend to chat a lot. Guys download a lot of MIDI’s. I think they use like Star Wars things. Games are more male-dominant. It [Gemstone3®] should be equal, but
I don’t think the girls have discovered it. Because guys tend to be more computer literate.” (Liz B., female, grade 9)

“Guys, I think usually use computers... or they’re expected to do better at it. It’s just mainly inexperience. Girls can do it, but they’ve just had more practice.” (Kate, female, grade 9)

“Well, they [guys] think they know everything. They think they automatically are going to be good at it, so then they have more confidence. I have worked with computers a lot. We used to have Macs and now we have IBMs, so I have worked with a lot of different types and I have screwed up a lot of computers.” (Kate, female, grade 9)

“I use the e-mail and I go to chat rooms on the Internet.” (Mary, female, grade 8)

“Sometimes the boys are able to program the computer to do things, but that’s just like Jamie K. He likes to do that.” (Mary, female, grade 8)

“In my school, I think the girls use the computers more as, projects, like getting school work done, and guys go on there just to fool around and stuff. They tell their teacher that they are going to work on their project, but they go on the Internet and just look for stuff that’s personal.” (Alicia, female, grade 9)

“E-mail is basically the same for both sexes... The same sad puns and stuff. And basically, you use it the same way, like forwarding stuff and from friends of both sexes. Like one time you’ll get this really sensitive stuff that makes you really depressed, and other times...I don’t know if it’s just because all of my friends are really artsy people or something. I think guys use it [the computer] more for fantasy games. Like, Dungeons and Dragons and maybe Raiders of the Lost Ark and stuff like that.” (Rachael, female, grade 10)

“Boys always like to think they know more [about computers].” (Mary, grade 8)

“Some of my guy friends will tell me what kind of computers they have and you get a new one and they are like, Cool, what kind is it?” (Stacia, female, grade 8)

“I know what most people are doing on their multimedia projects. I know Eric—his is like...he knows so much about computers, it is scary! He like, knows how to do everything.” (Stacia, female, grade 8)

“I always used to see like lots of guys and not many girls using it, but now I see it’s equal now. And normally the skills are equal now, too. So it’s just about equal now. Most of the guys in my TAG class at school know lots about computers and they are always on the Internet and everything. And I’m always talking to them on Instant Messenger. But, you never really hear the girls talking much about it. But they do use it, they say. And I have seen them use it a lot, too.” (Chris K., male, grade 8)

*But it’s just not a part of their social conversation.

*Yesterday someone talked about how fast your computers are. And it was one of the girls that I interviewed and she said, “I don’t notice any difference. I use e-mail, guys use e-mail.” And I asked what you e-mail about. And her response was, the guy friends that I have e-mail about their computer, how fast it is and stuff. “Do you e-mail your girl friends on these same topics?” And guess what she said.

“No.” (Chris K., male, grade 8)
"*Do most of your friends that are girls use computers a lot?
Some of them do and some of them don’t. One of my friends doesn’t do her homework and
she just gets on-line all the time. And so she is kind of into computers. One of my other
friends is, too. She knows a lot about computers. She spends most of her time on them.
*Do you have guy friends that use computers or do you perceive that guys use them more?
I have guy friends that use computers. But they are basically the “nerd” group, you know,
those guys.
*I was kind of hearing about that yesterday. Guys that are big users are nerds, but girls that
are big users are big nerds.
Well, sometimes. Not really. The girls kind of just don’t get paid attention to in our school.
They don’t really care if the girls use computers or not, but the guys are just kind of in this little
group.” (Jackie, female, grade 9)

"I don’t see much difference in the use.
*Do you think that there is difference even though you don’t see it?
I think that maybe there would be. Because I am not actually sitting there observing, but...
*Do you think that girls use more leisure time for computers, not just guys do?
I think, in regard to be e-mailed and that sort of thing, AOL, that guys might use that more.
Because most of the people I know...actually, some of them access to it they just don’t know
how to use it.
*Guys or girls?
Girls.” (Sarah, female, grade 9)

C. Parents
"All that male dominant bull crap that we have going on in our society. I do a lot more gaming
than I do programming. And if something goes wrong I go, ‘Daddy’ and he comes and fixes
it.” (Alli, female, grade 9)

"I feel bad for those computer fix-it guys. My dad doesn’t like to fix computers.” (Mary,
female, grade 8)

“Our computer got hit by lightening once and he was bent on fixing it himself. It was kind of
funny to watch him.” (Kristen, female, grade 9)

“My dad uses the computer more, but that’s because he uses it at work. And my mom doesn’t
work, but she’s just starting to learn how to use the Internet and she’s catching on really
quick.” (Laura, female, grade 9)

“Well, my dad is more—my mom is really cautious. She thinks that everything we are doing is
like, we are going to crash the whole computer. Everything I download is like, ‘Well, that
made it crash.’ My dad doesn’t really—I don’t know—he does it and if something happens,
he’s just...He’s more ready to try stuff. So that’s between my parents.” (Kate, female, grade
9)

“I think my mom uses it more for communication. I know my mom uses e-mail and quick mail
a lot. Both my parents do, I mean e-mail and stuff. They aren’t into stuff like Instant
Messenger, where it’s like talking on the phone. Because, basically it is, only you can talk to
like seven people and only use one phone line which is nice.” (Alli, female, grade 9)

“I see my mom on it a whole lot more than I see my dad on it. My dad won’t use it for leisure
time. He does use it for his work a lot and for taxes and other business stuff, but he’ll never
use it for the heck of being on-line or on the computer or anything. It’s me, or my mom, or my brothers.” (Jessica, female, grade 9)

“My mom uses it [the computer] in school to be a teacher for organization of her notes and papers.” (Stacia, female, grade 8)

“He [dad] does a lot of taxes... he does the taxes on there. And he does a lot of stuff like, Quick Time or something like Excel, the databases. He writes his resumes on Word Perfect or whatever that is. I’ve seen him play a lot of games and he goes on-line a lot. She [mom] used to be a secretary of VESVA at Kennedy. And she was freaking out if she had to use Word to type up the minutes. She’s like, “What do I do here? How do I do this?” And so we finally convinced her to get an AOL name, but she’s never gone on.” (Kristin, female, grade 9)

D. Adults

“Well, there are some things like men go on-line to look for information their things, like tools. I am not discriminating that just males use tools, but that’s more of what they do. And um, fixing mechanical stuff. And women go on-line and look for recipes, usually. I don’t mean to discriminate against anybody, I mean, I’m sure males do, too and women do for tools and mechanical stuff.” (Liz B., female, grade 9)

8. SELF-INSTRUCTION:

A. Students, of either gender, are largely “self-taught” and find school-related computer courses relatively inadequate.

“Well, I actually learned most of my computer skills by getting them off the Internet. I learned how to write HTML. I learned it all myself on an Internet course.” (Jake K., male, grade 9)

“Mostly I just figured it [Excel] out little by little at home and from my dad and a little from my mom and my friends from school. Well, I took an HTML course and that helped me to better understand that. And also, some other aspects of using the computer, too. That was a non-credit course at the community college. I’ve always been interested in programming and I wanted to make my own web page and be able to do all the code myself and not just have to use a program. To be totally dependent on one program to color in the background... I wanted to be able to put color in background.” (Liz B., female, grade 9)

“Basically, you learn to teach yourself... my friends taught me some of the stuff and my dad helped me a little bit.” (Alli, female, grade 9)

“We had research projects both years that you had to use the Internet on. A lot of is learning how to use ClarisWorks in seventh grade. And learning how to use the Internet if you haven’t already learned, but I didn’t really need that because I had already learned how to use it. We did projects where we had to make databases, or make a spreadsheet from information.” (Laura, female, grade 9)

“I am one of those people that can figure out things just by looking at it, so I did most of it by myself.” (Jessica, female, grade 9)

“I learned some of them at school. It was just when I was messing around with the computer.” (Mary, female, grade 8)
"I learned my technology skills by just messing around, I guess. They have just recently upgraded to Gateways at our school. My dad's a teacher and I just go in after school and mess around on his computer." (Melisa, female, grade 10)

"Okay, I had no experience to do a project except for like the typewriter 'til I got to elementary school. And then we starting typing stuff in like third, fourth grade, or something like that. And we had Apples...they weren't like that...it was before the Apple/Mac merger. They were nice Apples, but they weren't like the most high-powered thing. I don't know, I just played around on those. I just found out what they could do. Because oftentimes...I like to be working on something and get the information. I have trouble like, you know at the beginning of class the teachers stand up and, say, lecture what you are going to do and how to do it, and then you go do it." (Racheal, female, grade 10)

"I learned Power Point with my friends. But I have just been doing computers all my life." (Justin, male, grade 10)

"I never read books or stuff like that. As soon as we got our computer, I got on it and started messing around and stuff, seeing what all the programs do. I got into the programs and just used them and see. If I locked it up, I restarted the computer and tried it again. Just I taught myself how to use them. I taught myself how to use the Internet and stuff like that mostly." (Chris K., male, grade 8)

"I learned mostly about Internet from my dad. And what I didn't learn from my dad I learned from my girlfriends." (Jackie, female, grade 9)

B. Boys enrolled more frequently in school-offered elective computer courses.

"I am going to be taking CAD next year — Regular CAD (Computer Aided Drafting) first semester and then advanced the second semester. Actually we have two keyboarding classes. I tested out of the first one and the second one I'm not going to take until next year." (Eric B., male, grade 9)

9. CLASSROOM TEACHERS LACK COMPUTER SKILLS:

Students view their classroom teachers as lacking competencies in acquiring computer skills, using skills in curriculum experiences, or facilitating student use of technology.

"More training? YES!!!!!!! SOOOO many of my teachers, past and present, have had no idea how to use their computers!!!! They learn how to do grades and QuickMail but then request the students help for anything else!!! Teachers NEED to be more prepared for our technologically advancing world...especially those that have problems turning on the machine!!!!!" (Alli R., female, grade 9)

"Some teachers need more training. It's somewhat pathetic when a student must guide a teacher through using a program that has been on their computer. If something is placed on a computer to enhance the teacher's organizational or teaching skills, they should know how to use it." (Liz B., female, grade 9)

"Some computer programs we do in school, but we haven't done any multimedia stuff. Most of them [the teachers] just use the chalkboard." (Eric B., male, grade 9)
"Well, I would like to say that I got my skills from school, but I really didn’t. Because our teacher underestimates our abilities and treats us as if we have never heard what a computer was until we got to his class. He’s like, ‘This is the mouse.’ He doesn’t really teach us much. He goes over stuff that all of us already know.” (Jake, male, grade 9)

"The high school kids get to use the digital cameras, but on a limited basis. Last year during a Holocaust unit, my class did Hyperstudio presentations on the Holocaust. We got to use the digital cameras to take pictures of each other to put on our presentation. The cameras are not widely used in my school, partly because I don’t think the teachers know exactly how to use them or incorporate using them into classroom curriculum.” (Kate, female, grade 9)

"Our teachers have been educated on using M-power, and I have already had to do an M-power presentation, and me being the only one other than the teacher that knew how to use it, I got to help my classmates with the project.” (Alicia R., female, grade 9)

"I think they need a lot more training. A lot of my teachers complain they can’t get the grades done because they don’t know how to load/run new software, there’s something wrong, etc. Some of my teachers don’t know how to run half the programs already on their computer!” (Kristen P., female, grade 9)

"I think teachers do need more training because very few teachers at my school know how to use even simple programs. They have to go and ask another teacher how to use the program and, if that teacher doesn’t know how either, continue to look until they find someone who understands. Also, if they had more knowledge, they would be able to teach us more things.” (Mary G., female, grade 8)

"Some teachers, like my science teacher, have had the training and exposure, but just because it’s different, they don’t like it. No one likes changes, so some teachers might not be willing to have the training. I do think, however, that teachers should be required to have some instruction on computers, if anything for their student’s sake. What if I have a question...I’ll lose a lot of valuable time on school work because my teacher doesn’t know anything about computers.” (Sarah B., female, grade 9)

"For the English and Math, they [teachers] didn’t know how to incorporate it [technology] into the things that we are doing. We didn’t have Hyperstudio and things like that at first.” (Kate, female, grade 9)

"Nobody [our teachers] uses technology. They’re clueless. I mean, they just got the new computers and there are like two people that know how to get on.” (Melisa, female, grade 10)

"Well, there are some technologies class, but I took an Industrial Tech. Class, but I didn’t learn very much from her, because she didn’t really know very much about it herself. There was just a book that somebody else wrote and she wouldn’t let us figure it out on our own.” (Justin, male, grade 10)

"Yeah, she’s an older lady. And I think she’s kind of inclined not to use them as much because she is always uncomfortable with them. But she’s not really like...I think she knows how to use them, she just doesn’t like to. Because I have never seen her ask a guy in our class for help, or a girl for help with the computers. She has never really asked for help. But mainly she gets on them after school.” (Jackie, female, grade 9)
*Did you have instruction at school about how to use computers?

"Hyperstudio a little bit, but our teacher wasn’t very...she didn’t know if very good herself..."
(Kelsey, female, grade 8)

10. RELEVANT SCHOOL TECHNOLOGY EXPERIENCES REPORTED:
Not all school experiences were trivial. Some were meaningful to the students and connected to their curriculum.

“I am going to be taking CAD next year — Regular CAD (Computer Aided Drafting) first semester and then advanced the second semester.” (Eric B., male, grade 9)

“Yeah, our teacher has this Internet computers class where you are required to use Hyperstudio to create two projects. Everybody in our class did that and one was required to be about the school. And we had Digital Cameras, scanners and everything to work with there. We used ClarisWorks, and after that we moved on to the Hyperstudio and using all that type of stuff. We did recordings with microphones and a lot of graphics. We used the Internet, but we haven’t really used databases and spreadsheets other than in that class.” (Eric K., male, grade 9)

“During school hours, I have had two experiences getting to use the ICN network in the last year and a half. One was just recently. My physical science class listened to an astronaut from Iowa talk, and then we had the opportunity for a question and answer session. I think about 50 schools were hooked up at the same time from all over the state. The ICN is used a lot for adult education and teachers, but several students also take classes over the ICN.” (Kate P., female, grade 9)

“Well, actually, going into high school, I somehow managed to land three different computer courses. So I am going to have a lot of technology experience. I’ve got Annual, Computer Tech, and Computer Graphics. Computer tech is like designing programs. Like designing stuff like Hyperstudio. Not doing Hyperstudio, but designing programs like Hyperstudio.” (Jake K., male, grade 9)

“We have it [Internet] at school. We have the ICN room and stuff, but we got it last year, but we didn’t really use it. The school board didn’t really enjoy paying for it and then never use it. So we are in there almost every day this year. We use the ICN [Iowa Communication Network] for a careers class. It’s an exploration thing and we talked with a Department of Natural Resources Worker.” (Kate, female, grade 9)

“In English we used Hyperstudio. We did a whole computer Holocaust unit. We had to do a time line on the computer and that was with word processing. We did a newspaper and had to pretend that we were a reporter during the Holocaust.” (Kate, female, grade 9)

“Oh, for a Mac in seventh grade we used a program about tangent and angles and it was a flight flier and you had to aim the plane at the target and try to find the tangent of the angle and so forth. But, nothing about Hyperstudio or Empower.

*And then was your math teacher male or female?
Male.
*And then what other courses have you had, have you had technology as part of a teacher’s presentation or your instruction?
In ITEC this year we had to record some of our woodwork materials. We made a product and we had to record some of that on a database. And so it did the math for you. As you typed in
the numbers, it would give you the profit or it would give you the cost of the item.” (Sarah, female, grade 9)

**11. MAC vs PC COMPUTER HARDWARE:**

| A majority of students used PCs at home for homework and leisure pursuits, while their schools generally had MACs installed for lab or classroom use. |

PCS AT SCHOOL:

"The computers in the classrooms and computer lab are all IBMs. We also have a Mac lab which has 15-20 Macs. These are only used for the keyboarding classes now. In our library, we have several IBMs, and also several Macs used for word processing.” (Kate P., female, grade 9)

"We have six different computer labs at my school. Two of the labs are open to all students and four of the labs are in private classrooms. Our main computer lab is used by all English classrooms and contains only Windows programs, and is also open to all students. The "Write Place", as it is called, contains computers that are about two years old. None of these computers are connected to the Internet. The Write Place computers have a program that lets a teacher any computer look at what a student is working on at any other computer. The second computer lab is open to all students and has Macs. It is used by the Business English classes. The oldest Macs are about 8 years old, the newest ones are about two years old. The newest computers are compatible with Window. None of these computers are connected to the Internet. Now for the private classroom labs. The two labs used for typing classrooms contain really old green screen Macs, which aren't connected to the Internet. The Journalism classroom contains only Macs that are about 2-8 years old. One computer is hooked up to a scanner and one computer is hooked up to the Internet. They have no Zip-drives for really big documents. The Industrial Ed classroom contains computers that were built—yes, hand built—by students. These computers are about one year old and are used for Power Point Presentations and Architectural Drawings. One computer is hooked up to the Internet and one computer is hooked up to a scanner. Only one computer—in the whole school—is open to all students for Internet use and this computer is located in the library!!” (Rachael S., female, grade 10)

“I don't think I've used a Mac in school since elementary school. Then it was ok to have such simple computers because not many advanced ones were available, and advanced stuff wasn't needed to teach us the ABC's. Now I use PCs ;)” (Liz B., female, grade 9)

PCS AT HOME:

“I have not bought any new home computer equipment except games for entertainment. These games include Millie's Math House and Bailey's Book House for my younger siblings and Independence War. At home I use a Gateway computer with a pentium II processor and a Canon bubble jet printer. At school, I use Macs. Our school just purchased seven iMacs and I have used them.” (Mary G., female, grade 8)

“At my house I used a Compaq Presario and at school, we use only Macs!!” (Stacia, female, grade 8)

“Our computer is a Zennith I think, it's IBM compatible though.” (Alicia R., female, grade 9)

“We have a brand new Compaq Presario.” (Melisa, female, grade 10)
"My dad rebuilt the other computer, so it isn't a specific brand name, but it is IBM compatible. I absolutely LOVE this computer, and I wish that we had some like it at school." (Laura, female, grade 9)

"We have a Gateway at home. We had an old Macintosh and we just wanted to get a new Gateway computer because it was a small computer. We have Macs at school." (Jessica, female, grade 9)

"My school basically (sic) only uses Macintosh's. I would like them to have ibm' compatibles and better software. At home i use a dell." (Chris K., male, grade 9)

"We have an IBM compatible at home." (Kate, female, grade 9)

"At home we have a Gateway. At school in Cedar Falls we have macs." (Mary, female, grade 8)

"We have an IBM compatible and we are going to get a new Gateway." (Melisa, female, grade 10)

HOME MAC USERS:
"I just recently purchased a new I-mac computer. (It's blue!) It replaced a Mac. (You probably know the kind.) I purchased it a couple months ago. I guess I lied. My parents purchased it! In my basement, there is a PowerMac. I'm pretty much surrounded by macs and mac-users. My school uses macs as well. We have two labs with about thirty computers in each lab. The computers have Word, Works, and some most have ClarisWorks. They are all linked to the Internet, but they're very slow!! Frequently, problems arise, and you can't even get logged onto the computer." (Sarah B., female, grade 9)

MACS AT SCHOOL
"We have one computer in a room and there's about like 30 kids in a room. *And in the lab? They are all Apple II's and they all really suck. No, everybody likes computers, except MacIntoshes. You hear everybody grumbling at lunch about how slow their MacIntosh is or 'Oh, it crashed again!' I like Windows or Gateways better." (Kristen, female, grade 9)

12. CAREER GOALS USING TECHNOLOGY:

Students see a direct application of their computer skills and use of technologies in relation to their future career goals.

"In college I am planning on going into the Architectural field, so I figured CAD would be pretty good for me." (Eric B., male, grade 9)

"I hope someday to be able to do something with computers, building them maybe. They are pretty interesting to me. I think I would like to build more powerful ones." (Eric K., male, grade 9)

"I'll probably use computers a lot because I'm kind of leaning towards being a writer for my career. And I already have some books started up, so I think I am going to be using computers a lot to put down my theories, the actual bodies. And in college, computers are growing more and more everyday." (Jake K., male, grade 9)
"I kind of want to be a computer programmer for like, games, because it's something that I enjoy." (Liz B., female, grade 9)

"I am going to work at the United States Army Medical Institute of Infectious Diseases (USAMID), actually. I read a book called the Hot Zone that I was really, really interested in. And I wanted to work with virus and Ebola. It sound kind of gruesome, but I like stuff like that. And I used the Internet and I went to USAMID's homepage and got to explore what kinds of degrees and stuff I need to work there and stuff." (Alli, female, grade 9)

"We had a Career Fair and I talked to an accountant and an actuary. They said that they are using computers almost all the time. Just word processing doesn't cut it anymore. You have to know how to use [computers]...like be able to fix it. If you make a mistake, you have to help the computer. And you have to keep learning new skills. You can't just stop" (Kate, female, grade 9)

"Yeah, I am going to become a computer programmer or something in medicine. There's too much math in that so I might not do that." (Melisa, female, grade 10)

"I want to be some type of engineer. They tell me I will use technologies in my field." (Justin, male, grade 10)

"I want to be a Veterinarian. You work with animals. *Would you use computers in Veterinary Medicine? How do you think you would use it? I don't know. Maybe in the future they use it to analyze diseases. You can type in the symptoms if you didn't know what it was. And it would come up with the disease and the cure. You do it to keep track of all the files of animals. *How else would you use the computer? I don't know. Maybe later on, when they are doing difficult surgery...I have seen a lot of the cases where have done a 180 turn and it's really difficult surgery. I would think that maybe computers would help them do it." (Kristen, female, grade 9)

"*Do you see using computers for multimedia when you grow up and go on through high school in your career? Um, yeah, actually I do. I am not really sure what I want to be. But I know at the beginning of the year, I was thinking about taking marine biology courses at Central Academy next year. You can't take it this year, but you have to take Earth Science and everything. And I was thinking about taking that. I think it would be really interesting. I kind of like water animals and I think...I know I read somewhere that scientists are trying to make dolphins talk back to people, make them able to talk. I know in the book that I read, it's a fictional book, that they could. The dolphins had already____, that they could talk back. And I think that technology would be a really big help, in not just doing that, in organizing data, like radar and things like that. Just doing things in that way. And also, if I am not going to go into that field, computer technology is...I mean, you can use it almost any time unless you are like a waitress or something. And even if you work at McDonalds, you still use technology because you are pushing buttons on the thing. So, basically, yes." (Jackie, female, grade 9)

"I want to go to college at ISU or anywhere in Colorado...or if I'm feelin really smart maybe one of the Ivy Leagues...Harvard or Princeton or Yale (but I generally don't really wanna work that hard!! :) )" (Alli, female, grade 9)

13. CAPACITY FOR PROBLEM-SOLVING:
A. Gifted students generally resist problem-solving instruction in relation to building multimedia-enhanced projects during the Multimedia Mania summer course instruction.

"I did not like it because it disrupted the smooth flow of my thoughts. When I am problem-solving, my thoughts come so swiftly that the process of analyzing my thoughts and placing them into neat little categories disrupts my flow of ideas and makes it harder for me to problem-solve." (Rachael, female, grade 10)

"I thought that it was too much work to try and relearn what we have been taught since first grade." (Laura, female, grade 9)

"The ‘problem solving’ part of Explorations hindered our actual project, slowed us down." (Jake, male, grade 9)

"We already knew how to do it [problem-solving] and it seemed like a HUGE waste of time when we could have been working on our presentations. Actually stopping to think about the steps in a problem made it more confusing than if we had just been given the problem and been allowed to solve it in our own way." (Alii, female, grade 9)

"It was so freakin boring! I believe this generation is more of a hands-on generation. One reason I came to the computer thingy (better watch it...I'm gettin technical again) I was expecting to get away from the normal class room setting and have 99.9 percent hands on. Instead, I got to re-re-re-re-re-re learn the steps of problem solving." (Kristen, female, grade 9)

"The Big 6 seemed...well, I guess to put in bluntly, kind of like a lot of bull to me because...Well, how you have to go through and write everything out, and with all of the other different things that we have learned at school and stuff and writing stuff down, I just don’t see the use of the Big 6." (Racheal, female, grade 10)

"Well, I found that, when he was telling us to do that. I just wanted to get going on the project because I wanted to see what I could do. Well, I just felt like it was keeping me from doing my project. And, I don't like to write about how I am going to do it. I like to start doing it and then figure out if what I am doing is what I like then." (Justin, male, grade 10)

"I would say a 7 because I like to work on the project, but they interrupt us a lot and they talk about stuff about the computers. Why don't they just let us explore? Isn't that what life is about? It's exploring. And then they give us these worksheets and these packets. And I don't see what has to do with it, like the journaling. I don't like to journal. And the Big 6. We all use it, we do it subconsciously, then why do we have to write about it? Yeah. I think we can solve the problem quicker by doing it subconsciously than having to actually think about it. So what I think of problem solving is when I am in a jam." (Kristen, female, grade 9)

"But we've kind of been taught it before without that thing where you have to imagine all your resources. I think that basically...I have another thing that a lot of people in my group and a lot of other people, just my friends in this class—they go through this process in their head and that's what I do, I know. I go do this process in my head and I don't really need to write it down because I can remember what I was doing. I know, like, I can get my resources. I kind of just go at it and never really think about it consciously. Possibly unconsciously my brain could be quite organized, but consciously it's not."

*Well, take the not writing it down out of it. And that was the only way that we, in our society, can demonstrate that we can do something would be by saying it or writing it. And
people are just doing it and thinking it. And that's where the writing down part comes in. But
extract that, when do you do it?
I don't actually think through them. I just kind of am like, "Okay, I have to think through the
problem." When we had to pick our problem for this, I just kind of... I was reading the book,
The Dolphins of Pern, by Ann McCarthy. That's where I kind of got my idea and my
inspiration about it. And I just thought, okay, this is going to be my problem. That was
before I got the worksheet on it. So I just went to the library that night and I checked out three
books on dolphins and I got information from them. And I went on the Internet and I found
information there and I saved it and I wrote notes on it and I saved it and I brought it here.”
(Jackie, female, grade 9)

B. Students with a higher tolerance for metacognitive thought about their work or about
problem-solving instruction produced electronic projects with greater depth, quality, or
complexity according to the final evaluations of their MM projects.

"Well, the Big 6 thing that we are doing, that helps because you have somewhere to start. It's
not just like you actually jump into it. You have steps to go through and you can see where
you're at and how far you have to go before you are finished. I started my Hyperstudio, my
Chicago Bulls thing at home before we came, looking for stuff. So I went in order without
actually knowing it. But it helps to like identify the steps.” (Kate, female, grade 9)

"I like learning about the problem-solving process. It was really helpful in locating sources
and processing information. It really made me think about my audience. I chose to present my
project on a program I had never heard of, m-POWER. This is similar to Hyperstudio. I
learned how to connect cards using 'hot buttons,' how to integrate short movie clips into my
program from a video, download a graphic (which I turned into a background), and how to
connect a slide on my m-POWER project to a site on the Internet. I learned so much about
identifying the steps in problem-solving. It was kind of hard to understand at first, but what a
help it was, once I got the hang of it! I also learned to scan in pictures and use a digital camera.
I feel I could use the computer better now, and catch on to other programs more efficiently and
quickly because of the experience. This class really stimulated me to learn more about the
computer, in general!” (Sarah B., female, grade 9)

"I think it was hard and boring for some because they don't use it often. I think if we were
really forced to use it on a regular basis, it would help out a lot.” (Kate, female, grade 9)

"The computer helps me solve a lot of my problems. It helps me stay organized. It helps me
to find the information I need to solve my projects. It really depends what kind of problem
I'm trying to solve for me to go into any deeper details.” (Liz B., female, grade 9)

"I finally learned the difference between a report and a research paper. 'Cause in a report you
kind of look at all your research but then you write what you've learned. But, in a research
paper you have to quote stuff word for word and you have to have so many sources.
It gets really frustrating sometimes trying to find all this stuff.” (Eric B., male, grade 9)

"*Do you think that you learned about problem solving connected to your project?
The organization part is the part that helped a lot. You know, was it Inspiration, that little
branching off thing? That really helped. I think that was cool.” (Stacia, female, grade 8)

"I think I might use it more knowledgeably now I have actually gone through the whole thing
and know what all the steps are. And it seems like a pretty good problem solving...like first
defining it and then researching it and stuff like that. It's what you normally do, but you
"Let's talk about that Big 6. Tell me about that. Your opinion of that Big 6 problem solving. Okay, well, it's a problem solving strategy that has six steps. Task definition, location and access, source seeking strategies, use of information, then you have synthesis and evaluation. And first you have to define your task so know what your problem is, or what you are perhaps researching on. Like mine would be wolves. I'll just use mine for an example. Then I think of what I could use. I could use the Internet, I could call people, I could write letters, I could look at books, movies, the Internet. And then I decide what I am going to use and then I locate my sources and I dig for information and I write down the sources. And the use of information—I have to read through all my information that I gathered from the sources and decide what I need to use from that. And then I can choose what to put into my project or what to discard. Oh yeah, and then synthesis, I decide what categories I am going to put it in. In my project I separated it into six categories, I believe. That's just organizing and collecting your thoughts and then evaluation is looking at our project, when you see what... just evaluating it, I guess.

*You evaluate your project?
Yeah, I proofread it, I go through it, and I look at the rubric that we have.

*Do you think that the six steps has helped you with your problem solving skills?
It helps me recognize what steps I go through. When I problem solve, I look at the problem and try to solve it. Or whatever the problem is. And I hadn't really identified the steps and locating the sources and processing the information, and you know I had never really run into something like that. So I figure it is helpful.

*Do you think it transfers to other situations? Like for the rest of your school years or the next time you are looking for a project's goals or even just regular life dilemmas?
I don't think I'll consciously think, "I'm using the Big 6 right now." But I'm sure that I'll identify sometime just using the steps." (Sarah, female, grade 9)

**So you really think that student commitment would make a difference in learning the skills, applying the skills, making the class more beneficial for the other participants, as well as _____.
Affirming, yet firm, I believe that is what you just said. Speaking of future, do you think you will use these skills in the future? The problem solving skills? The computer skills? Oh definitely, in anything. I gave you some examples. You had to tell how the Big 6 would affect your everyday life, like with running. Okay, here's my problem. Now I have to go and find the right pair of shoes or the right outfit to run in. And then, you have to get a stopwatch or whatever. And then I have all this information, so then I have synthesis. It's so weird how it affects everything.

*It is across disciplines.
And I know that I will use the skills from the multimedia in messing around with the computer, trying to fix errors and problems. And I will take those skills with me.

*Do you think you have become more savvy about that fix-it business?
Yeah, just by, because there were usually only two people in there. And a lot of people had questions and not all the time could you go, "Oh, I have a question," and they would come right over to you to mess around with it. And then your last resort would be to ask." (Sarah, female, grade 9)

**COMPUTER AS A PROBLEM-SOLVING TOOL:**

Students reported varying ways that computer technology can be a tool to help them with problem solving, but they also saw the computer as a problem needing to be solved!
"The computer is a tool for problem solving because when something doesn't work you go through the problem solving steps to try to fix it. For example, when my printer didn't work, I tried to fix it myself by finding out what the problem was. When I was unable to locate the problem, I called the company and am now able to use the steps they told me to find the problem and fix it. By calling the company I used problem solving skills I would not have needed if I didn't have a computer." (Mary G., female, grade 8)

"Computers help with problem solving because you have to be able to figure out how to fix the problems and make things work right. Macs are GREAT for teaching problem solving because they give you errors every two minutes and all it says is "error type 2", it that doesn't teach problem solving what does?" (Melisa, female, grade 10)

"Computers are not normally problem solving tools, but they are problems to solve." (Jackie, female, grade 9)

"The computer presents, as we all know by now, many of its own problems. In fact, just trying to get into hotmail on this comp was a problem that needed to be solved. I tried different ways of logging in, restarted Netscape, tried composing an e-mail to get in, and at last, right before I gave up, I waited a minute longer after logging in, and PRESTO! my e-mail list came up. The computer challenges you and makes you retrace steps, figure out what you did wrong, and provides ways for you to fix your mistakes." (Sarah B., female, grade 9)

"If your problem is that you have a 12 page report due in a week and you've had three months to do it, then you get on the Internet really fast and get a whole bunch of information that you can put into your report. And you couldn't do that without Internet. You'd have to go to the library and take a lot longer if you had to do everything...look it all up. Computers are really helpful in making things look really neat because it's all uniform." (Alli, female, grade 9)

"How is the computer a tool to help you with problem solving? Well, if you have to find a book for a research project, not only can you locate, and buy a book, you can search on the Internet for info on your topic or e-mail an expert on your topic or someone with information that should help you. That would solve your problem of finding out info on your topic." (Alicia R., female, grade 9)

"Well, because if someone has a problem in their project, then they need to know how to get through that, so they can breeze right on through. Technology—not only does it get them out of a jam, pretty much—but it almost always incorporates a way for you to learn how to do that again next time." (Jake K., male, grade 9)

"Also, sometimes if you have a problem with the computer, and you don't know what the problem is, and you have to go and experiment with everything to see if you can get the error out of the system or whatever. The more you use computer technology, once you use a program and you use a different program, then you sort of think, Oh yeah, I used that in the last program so maybe I can apply it to this one. And you just keep growing." (Sarah B., female, grade 9)

"Computers [word processing] help you do reports, edit, cut and paste, highlight and delete. Well, with tables, it helps to lay things out. Once you have things laid out in a table it helps to solve the complete puzzle. Sometimes I use Excel." (Liz B., female, grade 9)
"The computer is a tool to help me with problem solving because there are so many various applications to do on it. The computer is a resource that can do almost anything."
(Kate, female, grade 9)

"How is the computer a tool to help you with problem solving? I don't know what you mean by problem solving... if it's what we did at camp then I'd have to say our brains are the biggest tool, but the computers help us organize our thoughts!" (Stacia, female, grade 8)

15. CULTURE OF COMPUTER-USING ADOLESCENTS:
Use of abbreviated language and symbols punctuated student digital communication style, which while varying in access and frequency, had similar style with females using more symbols than males in their e-mail communication.

TTFN stands for Ta-Ta-For-Now (Tigger from "Pooh Bear" used to say it in the old movies)
TTYL means Talk To You Later!!
NM never mind
G2G got to go
GTG Got To Go
ROFL Rolling On the Floor Laughing
ROFLMAO Rolling On the Floor Laughing My @$$ Off
BRB Be Right Back
BBL Be Back Later

Other than that, you have all the "smilie" faces:

:-) Standard Smile
:O Standard Shortened
;-( or ;) Winking
;>) Devilish
;-( or :( Sad
;=) Second Standard Smile
8^) Sunglasses and Carrot Nose (which can be added to any)
;)=) Gotee wearer (can go on any one)
0=) Angel
;}=) Devil
;P Sticking Tongue Out
<=) Conehead

There are a ton of faces, but on IM :-)) looks "kinda kewl," and :^)

#:-) funky hair
{:-) more funky hair
:-P tongue sticking out

@@@@@@=) Marge Simpson

^_^ It's an animal face!!!
(that animal character ate a lemon!)

@-->--- (rose)
<3 (heart)

AFK~ "when you are chatting, it means Away From Keyboard... basically means they're probably still on the computer but don't want you to IM them at the time."

@..@
(----)
(<-->)
^\_\_\_\_\_

Parents are not necessarily aware of or privileged to e mail or Internet activity of their children.

"My dad would kill me if he knew I was still E mailing that guy from New Jersey."  (Alli, female, grade 9)

My mom is paranoid about my use of the Internet, but she doesn't want me going into chat rooms. I have my own address, but she doesn't know that I do, so that's fine.  (Laura, female, grade 9)

"My mom doesn't want me to go into chat rooms. She doesn't want me to give out my address and stuff."  (Mary, female, grade 8)

"My dad does not have any input with what I do on the computer."  (Kate, female, grade 9)

"I think my dad doesn't know, because my dad leaves for work at 6:30 in the morning, and so I have the home all to myself, me and my sister, and she doesn't really care. And my mom is either on the phone for business or she's at work. So I am by myself and I don't think anyone really knows."  (Alli, female, grade 9)

"I used to get a lot of this really sick mail and invitations to porno web sites. And my dad showed me how to put a block on my e-mail and I'm really happy."  (Kristen, female, grade 9)

"I put on blocks, too."  (Liz, female, grade 9)

"My dad doesn't really ask us. He doesn't really know. He never goes on."  (Alicia, female, grade 9)

"My parents read my e-mail and it drives me nuts. That's why I got my own. Like, my mom replied to one of my friends once!"  (Kate, female, grade 9)

"My mom wouldn't let me go into chat rooms or anything until I got like a separate e-mail address to use. So that it didn't have my real name or anything. She's like, "okay, you can talk to whoever you want to as long as you don't tell them where you live or your name or anything. I said, "Mom, I'm not stupid."  (Alli, female, grade 9)

"Well, I don't have e-mail at home, but I use my friend's when I go over there. That's the first thing we do is get on the Internet and chat and stuff."  (Stacia, female, grade 8)
"Wierd stuff on the Internet? Well yeah, i started my own samurai clan, signed on to red dwarf fan club, began a religion, stuff like that." (Jake, male, grade 9)

16. CHALLENGING RESPONDENTS:

Gifted adolescent learners can be rather challenging, opinionated students with whom to work and communicate.

"P.S. Could you stop putting the stuff in things like bold lettering or different fonts? It comes out like this on my screen and is very annoying."

(Kristen P., female, grade 9)

"Question to Melisa: What have you learned about yourself from thinking about all of these questions? "That I don't like answering stupid questions unless I'm getting paid :)")

(Melisa, female, grade 10)

"Okay. Now I have all these thought going through my mind. I have to figure out how to translate them. Um, I think one of the major problems I have with like translating my thoughts is that I jump topics really quickly. So it kind of comes across as scatter-brained, because I think really quickly. And people, most times, don't follow what I say. And I don't want to offend people. I don't want to say something that could be interpreted the wrong way. Because through experience a lot of things that I have said have been interpreted completely different than what I meant them. So, not only...so a lot of times, I just think of something that I have been trying to figure how to word it best, so I don't get a result that I wouldn't like, or..."

(Rachael, female, grade 10)

"I wish I had more time to work on my project. Or just have a block of...I don't mind all the teaching stuff they do. But I just don't like how it's set up so you work for awhile. And then once you really start doing stuff it's like, "Okay, everyone, save your work, turn off your computers." I wish they just had one hour where they had all the teaching stuff and then they could have uninterrupted time to work."

(Rachael, female, grade 10)

"First of all, I don't think that there are many 'subtle and blatant discriminatory experiences which limit female accomplishment using computers.' I think that there aren't really many females interested in doing worthwhile things with computers. Maybe in a few years things will change, but I think that until there are more computer classes in school there won't be as many females interested.

I hope you don't consider me rude for being blunt about things. If I can suggest one thing for you though, it would be not to 'criticize' or be 'sarcastic' towards the people that you're asking questions of. Note the following: (and please don't answer "nope" or "I don't know") You asked, 'What will you spend your $20 on? I don't know. How would YOU elaborate on "I don't know"?'

You asked. 'Do you have any questions for me?' I said, 'Nope.' If I didn't have any questions, how am I supposed to elaborate on that?
17. TECHNOLOGY IN THE FUTURE:

Students see technology as a tool for their future and the future of the world in which they live.

"In the future, I think computers will be faster (but not the Internet). They will have pretty much solved the Y2K problem, except for maybe a few people, and maybe the Y3K problem (for when it's 3000 A.D.). People in "developed" countries will become more and more dependent on computers, so computer disasters will become more and more devastating. Meanwhile, "developing" countries less dependent on computers will become even less dependent when their unprepared computers shut down at Y2K. While their poverty, famine, unrest, disease, and hardship will almost certainly continue as it has for the past several thousand years, they will probably mature (if only those dang civil wars will stop), while 'advanced' Western civilization will decline and go the way of Babylon and Rome." (Julie L., female, grade 9)

"I have no idea...most likely, smaller, faster, more efficient, and (initially) more expensive. It will also probably be better planned for stuff like Y2K. It may get rid of the keyboard and use audio signals instead. Gaming will become more refined and we will be more connected by the computer. In fact, the computer could become the central part of our life. School, work, fun, everything could be done on the computer. My friend Karena even has television access from her computer. SOOOO much more refined!!!" (Alli, female, grade 9)

"I think comp tech will limit and reduce our daily conversation. Already there are ways of talking to people without "talking to people" (much like I'm doing now.) Communications will be reduced greatly because of the possible chance of having techno-school (classes over the internet). I think, this may sound hypocritical considering I'm pro-techno, that the future technology will be dangerous to our society. It could wipe out communication so much, that future generations won't be able to express their true feelings. You might say now, well, they'd be able to write them down and send them to the person on the internet. But I say, how will they be able to express those feelings meaningfully in words if they never had anyone use expression in their voice. Can you imagine having a class held over the internet? Think right now of a teacher you really loved as a child, or even in college. Can you picture the expressions they used? Can you hear the way they talked to you with love and compassion? How would students get the same encouragement if they never heard or saw their teachers, just read them." (Sarah B., female, grade 9)

"I think computer technology will be very advanced. I think we will receive less and less postal mail and more and more e-mail. A lot of things will be able to happen as a result." (Kate, female, grade 9)

"future? vr interface." (Jake, male, grade 9)

"I have no idea...most likely, smaller, faster, more efficient, and (initially) more expensive. It will also probably be better planned for stuff like Y2K. It may get rid of the keyboard and use audio signals instead. Gaming will become more refined and we will be more connected by the computer. In fact, the computer could become the central part of our life. School, work, fun, everything could be done on the computer. My friend Karena even has television access from her computer. SOOOO much more refined!!!" (Alli, female, grade 9)

"There is no knowing what the future holds for us. Computers will continue to "evolve" into more and more complex and small devices. Maybe we will even have microchips in our brains so we can access information without a computer." (Liz, female, grade 9)
"This may sound really stupid, but I think computers and people will be able to interact. Computers could possibly have personalities. I think everything will be voice commanded... "Computer! Where's my dinner?". And so on and so forth." (Kristen, female, grade 9)

"Everything is getting smaller. Some day there will probably be computers size of watches, but I wouldn't like them. Today's calculators are basically like little computers. The Ti-83, a graphing calculator, can do any kind of math problem, as well as play games, store and organize telephone numbers, and write messages to other calculators. In the future, I will probably have a portable computer the size of my Ti-83." (Rachael, female, grade 10)

"I think technology will become much faster. I also think that now expensive programs will become cheaper as better ones come out. I think you will be able to do much more, although I do not know what. It seems as though you can do everything now, but I'm sure in the future there will be more." (Mary, female, grade 9)

"Computer technology will be more foolproof, everyone will have a computer. Sometime in the future I think that computers will replace homework in school, you won't have to turn in a hard copy, you will just be able to e-mail it to the teacher." (Melisa, female, grade 10)

18. IN ONE WORD: LEVEL OF CONFIDENCE

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<th>Female students were self-described as more tentative users of computer technology, while males reported higher levels of both confidence and competence.</th>
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MALES: confident, very confident, great,

FEMALES: solid, pretty good, good, fine, growing, apply what I know, imitation,
APPENDIX R.
ACCOMPANYING CD-ROM AND RELEVANT TECHNICAL INFORMATION

System requirements for CD: Power Macintosh or higher computer.

CD contains raw data on transcriptions from student interviews, transcriptions from focus groups, e-mail messages from respondents, and Evaluative Narratives from Multimedia Mania Instructors.

Original data was collected June, 1999 through May, 1999 was saved and formatted using Microsoft 6.0.