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MOVING BEYOND THE TOY VS. TOOL HYPOTHESIS: AN EXAMINATION OF GENDER DIFFERENCES IN ADOLESCENTS' COMPUTER ACTIVITIES, ATTITUDES, AND TECHNOLOGY-RELATED CAREER PLANS

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ABSTRACT

In order to provide some explanation for the gender gap within the IT workforce, the current study offers a detailed look into the evolving ways adolescents use computer technology. Guided by Eccles expectancy-value model of achievement motivation, the study examines associations between adolescents' career attitudes and expectations for success, values, and activity-involvement. Student participants (n = 460) from two high schools in central Pennsylvania took a web-based survey that assessed their computer attitudes and activities. Results suggest that adolescent males and females spent about the same amount of time on computer activities each day. Gender differences, however, were found with respect to computer attitudes and career beliefs, and many of these gender differences were larger among 12th graders than 9th graders. Moreover, adolescents' self-confidence, reports of troubleshooting, computer time with friends, gender beliefs, and enrollment in computer courses were significantly related to computer career interest and efficacy. Overall, results suggest that the original "toy vs. tool" hypothesis has become too simplistic and will not help researchers understand the current gender divide in the technology workforce.

Table of Contents

List of Figures

List of Tables

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"We are at a point where everything is changing incredibly rapidly. Technology is a huge driver of that change. We have lots of choices about how it gets created and how it gets used. Women have to be there helping make that choice, or we will just get left out."

~Dr. Anita Borg, president and founding director of the Institute for Women and Technology

Introduction

In August 1995, President Clinton challenged the nation to work together to ensure that all children in the United States would become technologically literate by the year 2000. He outlined a plan that would universalize home and community access to the Internet, help provide computers for all teachers and students, and give schools effective and engaging software, on-line learning resources, and teacher training (Sommerfeld, 1995). It appears as though Clinton's initiative is coming to fruition. The nation has experienced a fivefold increase in the proportion of households with computers since 1984, with recent data suggesting that the majority of American children and adolescents are regular users of the computer and Internet. In fact, nearly 80% of households with children in the United States own a computer, and more than 75% of families have access to the Internet (Kim, 2004; National Telecommunications & Information Administration, 2001). Not surprisingly, more households have Internet subscriptions than newspaper subscriptions (Woodward & Gridina, 2000).

Adolescents are the fastest growing segment of Internet users, reporting heavier use than their parents (Subrahmanyam, Greenfield, Kraut, & Gross, 2001). In fact, 75% of adolescents are frequent Internet-users, spending over 12 hours online each week engaged in activities such as homework, chatting with friends, playing games, and finding information related to interests and hobbies (Debell & Chapman, 2003; Ubois, 2002). Many adolescents report having computers in their bedroom, and over 10% of adolescents use the computer for more than 16 hours a week (Lenhart, Simon, & Graziano, 2001; Rideout, Foehr, Roberts, & Brodie, 1999). Interestingly, when adolescents were asked to name the *one* object they would choose to take with them to a deserted island, more chose a computer with Internet access than anything else (Rideout et al., 1999). Not surprisingly, over the past few years, parents' most common form of punishment has become grounding adolescents from the Internet (Tell, 2000).

Although Kirkman (1993) found that more than 90% of most adolescents' computer use was at home, students' exposure to computer technology at schools is also increasing. In fact, U.S. school districts were estimated to spend $7.19 billion on technology and computer-related projects during the 2002-2003 school year, and 96% of K-12 public school teachers report that they use the Internet as a teaching tool and resource (Quality Education Data, 2003). Recent federal research found that 99% of American public schools have Internet access for students (Parsad, Jones, & Greene, 2005), and some states have mandated that students pass a computer literacy exam to earn a high school diploma (Tell, 2000).

However, as the popularity of technology continues to flourish and drive the American economy, recent studies suggest that the revolution may be leaving females behind at later ages (Cooper & Weaver, 2003; McDonald, 2004). Employment data from the U.S. Bureau of Labor Statistics show that the U.S. high-tech computer industry employs nearly 5 million workers, making it one of the nation's largest and most lucrative industries (Commission on the Advancement, 2000; Deagon, 2004). Moreover, the demand for workers in computer technology will increase three times faster than all job categories in this decade, with the creation of 2.2 million jobs in the computer field (Deagon, 2004). Yet the number of women earning computer science degrees in the United States has plummeted over the past two decades, causing women to be vastly underrepresented in the computer technology workforce (Department of Commerce, 1999; McDonald, 2004; National Science Foundation [NSF], 2004).

Thus, although most adolescents routinely use computer technology, regardless of sex, a significant gender gap still exists within the information technology (IT) workforce. After high school, the majority of young women make academic choices that steer them away from computer and technology-related careers (Grundy & Grundy, 1996; Stabiner, 2003). It is unclear why this gender gap in IT career-related beliefs and decisions appears as adolescents finish high school and start planning for the future.

The current study explores possible reasons for the apparent gender gap in the IT workforce. First, gender and grade-based differences in adolescents' computer-related career plans and motivational factors such as activity-involvement and attitudes about the computer were examined. Second, the relation between adolescents' computer attitudes, computer activity-involvement, and computer-related career beliefs was investigated, with close examination of the interaction of sex with computer attitudes. Third, analyses examined individual differences in computer activities, helping to delineate between several distinct groups or clusters of adolescents. Finally, individual differences in computer activities (as defined by the clusters) were related to career beliefs.

Analyses were guided by application of Eccles and colleagues' (1983) expectancy-value model of achievement motivation to the domain of computers and technology. Generally, it was expected that adolescents' computer activities and attitudes would be associated with computer career goals, with gender moderating these relationships. In particular, as predicted by Eccles and colleagues' (1983) model, it was expected that adolescents' achievement-related experiences (computer activities), expectations for success, and value (computer interest and utility value) would be related to achievement-related choices, specifically computer-related career beliefs.

Literature Review

The following section provides a brief review of gender differences in the IT workforce and highlights the importance of considering age-related differences in career beliefs. Next, Eccles' and colleagues' (1983) comprehensive model of achievement motivation is explained and links are made to the domain of computers and technology. A review of empirical research on gender differences in math, science, and technology follows, focusing on research that has examined the key variables that make up the comprehensive model of achievement motivation. This section also includes an explanation of the current direction of research on gender differences in computer activity-involvement and beliefs. Finally, the limitations of measures used in past research are discussed.

Gender Differences in Computer-Related Careers

Although a gender bias favoring boys existed with regard to computer use in the early 1980's, researchers believed this bias would decline as computers became a routine piece of equipment in every classroom and the majority of homes. The computer, according to Watt (1984), was seen as the great equalizer. If children were exposed to computers at both home and school, girls' and boys' use of the computer would even out. Although this is generally true, with current statistics suggesting that most adolescents routinely use computer technology, regardless of sex, a significant gender gap still exists within the IT workforce (e.g., Cooper & Weaver, 2003; Debell & Chapman, 2003; see Heitner, 2002; Ubois, 2002).

In fact, both the proportion of female students graduating with degrees in computer science and the absolute number of female computer science undergraduate students have declined in the past 15 years (Dryburgh, 2000; McDonald, 2004). According to UCLA's annual survey of over 400,000 students at colleges and universities nationwide, only 1.8% of women, compared to 9.3% of men said they planned to enter computer programming as a career – the largest gap in the survey's history (Mayfield, 2001). Similarly, among high school students, girls represent only 17% of the computer science advanced-placement test-takers (AAUW Educational Foundation, 2000). Computer science is so unpopular among adolescent girls that even the most rigorous girls' schools rarely find enough students to fill one class (Stabiner, 2003).

This gender gap in the IT workforce has existed for several decades, and seems to be increasing (Gilbert, 2002; Panteli, Stack, & Ramsay, 2001; Stabiner, 2003). In 1975, women received approximately 19% of all bachelor's degrees in computer science from PhD-granting universities. This number gradually grew, reaching an all-time high of 37% in 1984 (Furger, 1998); however, the female share of bachelor's degrees in computer sciences began to drop in 1985, dipping to 28% in 2001, while male rates increased (NSF, 2004). Currently, at top research universities, females represent only 15-20% of computer-related majors, and this number has decreased almost every year over the last decade (Camp, 1997; Gilbert, 2002). Consequently, women make up only one out of five information technology professionals (AAUW Educational Foundation, 2000; NSF, 2004). "You look at the national statistics," says Rick Rashid, senior vice president of research at Microsoft, "and you just have to be appalled" (McDonald, 2004).

Women will pay a high price if they remain mostly outside of the evolving technical career world. Compared to other occupations, the computer industry offers some of the most lucrative starting salaries (Cooper & Weaver, 2003; Gilbert, 2002). Moreover, by the year 2010, 25% of all new jobs created in the private and public sectors will be "technologically oriented" (Wood, 2000). Technology is one of the areas where the United States is in a leadership position, according to Berl Hartman, vice-president of a leading U.S. database firm. Hartman argues that "Technology is one of the engines driving growth. If women are not versed in technology, they will be left by the wayside in the next millennium" (Debare, 1996).

Until recently, many top IT jobs were filled with students from international doctoral programs. But homeland security issues and visa requirements have clogged up the pipeline from abroad (McDonald, 2004). “Over the next seven years, our hiring needs are going to be huge," says Wayne Johnson, executive director of Hewlett Packard’s University Relations Worldwide. "If you don't have half the U.S. population participating, you have a tremendous gap in filling these needs. What we're doing here is creating a disadvantage for ourselves as a nation" (McDonald, 2004). This critical shortage of computer scientists in the United States is expected to become greater in the next decade (Camp, 1997; Cooper & Weaver, 2003; Deagon, 2004; Gilbert, 2002; Margolis & Fisher, 2003; McDonald, 2004). Certainly, encouraging women to obtain the necessary training to fill these jobs and accrue the economic opportunities they provide will help remedy this shortage and address issues of equity within the field.

Women’s ideas and contributions to the world of technology are critical. Jane Margolis, a social scientist who has examined the computer science gender gap, argues that it is important for the overall health of the computer industry that women participate (Margolis & Fisher, 2003). Margolis suggests that when industries are dominated by one group (e.g., men), products become flawed, and in some cases can prove costly, not only in profits. For instance, air bags and artificial heart valves were originally designed by all-male mechanical engineer teams and ended up being potentially deadly to women. Similarly, at one California communications firm, engineers could not understand why a hospital emergency-messaging device, triggered by voice recognition, was not working. Someone eventually noticed that most of the nursing staff was female, though the voice-recognition software, which was created by a team of men, had only been tested on male participants (McDonald, 2004).

Industries that are composed of different viewpoints lead to varied products that meet the needs of a broader number of people (Margolis & Fisher, 2003). Ideally, the computer workforce should be composed of women and men from different ethnic and social backgrounds, resulting in a rich collection of ideas (Chaudhry, 2000). "If you've got a bunch of nerdy white guys creating the technology, you get stuff that appeals to nerdy white guys," says Greg Papadopoulos, chief technology officer for Sun Microsystems. "If you want to turn out more usable products, you'd better get more women involved" (McDonald, 2004).

According to Cooper and Weaver (2003), social gaps in society cause the digital divide, and the digital divide, in turn, may intensify existing social gaps and create new ones. Clearly, the inclusion of women's ideas and contributions within the world of computer technology is critical to the overall health of the computer industry and a variety of other technology-driven industries, in order to ensure that a variety of perspectives are included in product design and application (Chaudhry, 2000; Margolis & Fisher, 2003). Unfortunately, after high school, the majority of young women continue to make academic choices that steer them away from technology and computer-related careers (Grundy & Grundy, 1996; Stabiner, 2003).

Age-related Changes in Career Beliefs

Although the main purpose of the present study was to investigate gender differences in adolescents' computer attitudes and activities, and examine the relation between these factors and beliefs about computer-technology careers, analyses also examined age-related differences, specifically comparing beliefs and activities of individuals entering high school (9th graders) to the beliefs and activities of individuals who were nearing the end of their high school experience (12th graders). Past research suggests that individuals' values become stronger predictors of career-related beliefs and decisions as individuals reach the end of high school and begin to focus their activity-involvement in areas that will be most important for their future. Moreover, gender differences in the value of gender-stereotyped domains such as math, science, and technology seem to increase in later adolescence (Wigfield & Eccles, 2000). Thus, it is important to consider age-related differences in beliefs and attitudes when examining expectations and career-related beliefs and goals.

According to Raskin (1998), by the time students reach their sophomore year in high school, they are aware of their interests and begin to narrow down career choices to at least two or three occupations. Some occupations, especially those in math, science, and technology, must be chosen during the early adolescent years, allowing students to take necessary classes that will prepare them for college. For adolescents who do not plan to attend college, such choices need to be made even earlier, so students can make good use of early training and entry-level career opportunities (Holland, 1985). Thus, it is important to understand how adolescents' computer activities and attitudes are related to their career-related beliefs and goals during this critical time period, and investigate whether the relationships between these constructs differ among 9^{th} and 12^{th} graders, as adolescents' career goals become more focused.

As Wentzel (1992, p. 302) suggests, adolescence is an interesting period of development for studying individuals' multiple goals and interests as they "coordinate and achieve diverse social and academic outcomes in positive and complementary ways." Some research suggests that females have more competing interests and abilities than males, attracting them to a broader range of educational and vocational pursuits (Benbow & Lubinski, 1997). Although educational opportunities and positive experiences with computers and technology may provide the necessary conditions for later computer participation and career-related goals, factors such as early career aspirations, values, and attitudes toward these fields may become equally important during the later years of high school and beyond. Career decisions and attitudes may develop independently of students' actual computer abilities or skills and may "cast the deciding vote" on whether individuals pursue further study in the domain of computer technology (Catsambis, 1999).

Wigfield and Eccles (2000) suggest that the interest (or intrinsic motivation) component of value may be especially salient during childhood, when activity choices are directly related to interests. Children are likely to be interested in several domains and try many different activities before developing more stable opinions regarding the activities they enjoy the most. As individuals reach later adolescence and develop more stable self-schemas and long-range goals and plans, however, the perceived utility and importance of various tasks becomes more important to the development of values. Thus, as individuals near the end of their high school years, their values about domains deemed most important serve as essential predictors of educational and career plans and goals.

Summary

Despite the growing popularity of computer technology among adolescents, gender gaps in educational and career plans are still evident within computer science, regardless of ethnicity or family-income. Thus, the current study examined gender and age-related differences in adolescents' computer-related career beliefs and motivational factors such as activity-involvement and attitudes (e.g., value, interest, gender stereotypes, expectations for success), and examined the relations between such factors. It was expected that gender differences in adolescents' computer values and outcome expectancies would be greater among older adolescents whose educational and career plans are generally more focused than younger students.

Theoretical Background

Over the past twenty years, researchers have studied the motivational and social factors that influence males' and females' achievement goals, behaviors, and career choices. Because of the striking gender differences in achievement goals and behaviors in domains such as math and science (NSF, 2000), researchers have been especially interested in comparing the motivational factors underlying male and female achievement-related decisions in these areas. Drawing on the theoretical and empirical work associated with achievement motivation, self-efficacy, attribution theory, and gender stereotyping, researchers have elaborated a comprehensive theoretical model linking achievement motivation and career-related choices (see Jacobs & Eccles, 2000; Eccles, Barber, & Jozefowicz, 1998).

This comprehensive model of achievement motivation, developed by Eccles and colleagues' (1983), links achievement-related choices to two sets of beliefs: individuals' expectations for success and the importance or value an individual attaches to a domain (see Appendix A, Figure 1). The model, commonly referred to as the *expectancy-value model of achievement motivation*, also specifies the relation of these beliefs to cultural norms, experiences, and abilities. In particular, the model links achievement-related beliefs, outcomes, and goals to interpretive systems like causal attributions, the input of socializers (e.g., parents, peers), gender-role beliefs, and beliefs about the domain itself. Eccles et al.'s (1983) model assumes that achievement-related choices are guided by one's expectations for success, the interest the individual has in the domain, the value the individual places on the domain, and one's gender-role schemas (Eccles et al., 1998).

Individuals' expectations for success have received much research attention, especially with regard to gender differences in achievement motivation during adolescence. In Eccles and colleagues' expectancy-value model, individuals' expectations for success are commonly referred to as self-perceptions of ability or self-concept, and are measured by asking individuals about perceived competence in a particular area (e.g., mathematics) or on a particular task (math homework, computer programming). Self-concept researchers are interested in the iterative relation between perceived competence and performance in activities, and they suggest that one's self-concept guides, regulates, and motivates behavior; similarly, one's behaviors and activities also influence individuals' expectations for later success (Eccles et al., 1998).

Eccles and colleagues' work with expectations for success has been accompanied by the work of researchers such as Bandura (1977), who defines self-efficacy as an individual's beliefs concerning his or her ability to perform given tasks or behaviors. Bandura distinguishes between efficacy expectations (i.e., the belief that one can accomplish a task), and outcome expectancies (i.e., the belief that a given action will lead to a given outcome) (see Wigfield & Eccles, 2000), and argues that self-efficacy is determined by previous performance, psychological reactions, and modeling and encouragement from others. Moreover, Bandura suggests that causal attributions only influence behavior through their impact on efficacy beliefs; thus, he believes that self-efficacy research is task/situation specific and strongly related to behavior (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996).

Taken together, the perspectives of Eccles et al. (1998) and Bandura et al. (1996) suggest that individuals are more likely to become involved in activities when they feel they can do well in those areas. These feelings of self-efficacy become strongest when individuals perceive past successes as being caused by their own ability or effort in the domain (see Dornbusch, Herman, & Morley, 1996). Thus, individuals who have succeeded with computers and technology in the past due to their own abilities or effort are more likely to choose to continue using technology in the future.

In addition to feelings of self-efficacy and expectations for success, the *value* that individuals' attach to achievement tasks is extremely important in Eccles' achievement motivation model (Eccles et al., 1998). In fact, recent research examining predictors of career plans in the domains of math and science suggest that value may be the most important factor, accounting for the major gender differences in math and science career plans. For instance, girls often reject careers in the physical sciences because they cannot make important links between these subjects and what they care about (Burkam, Lee, & Smerdon, 1997). Even after controlling for achievement, ability, and social background, female students are less likely than boys to enjoy mathematics classes and are less likely to believe that these classes will be useful for their future than boys (Catsambis, 1999). In contrast, biology and other life sciences have been traditionally viewed by girls as more interesting and caring branches of science that focus on living organisms and human health (Jones, Howe, & Rua, 2000), and thus offer more appealing career choices for young women. Therefore, according to Eccles and colleagues (Eccles et al., 1998), the value that an individual places on a domain is just as important as self-efficacy, or expectations for success, for determining future behaviors in a domain.

These early values seem to translate into later career choices within the broad domain of math, science, and technology. A recent study of college freshman by the Higher Education Research Institute (see Bae & Smith, 1996) showed that men were much more likely to pursue majors in engineering or computer sciences than women, while similar percentages of male and female freshman planned to major in the life sciences. Moreover, although women earned 45% of the doctorates granted in life sciences in 1999 (National Center for Education Statistics [NCES], 2001a), women earn only 23.4% and 14.9% of doctorates granted in the physical sciences and engineering, respectively (NSF, 2000; Sanderson, Dugoni, Hoffer, & Myers, 2000), and are significantly less likely than men to be employed in such fields.

Four components of value have been outlined in Eccles and colleagues' model: attainment value, intrinsic value, utility value, and cost (Eccles et al., 1983). *Attainment value* is the personal importance of doing well on a task. *Intrinsic value* is the enjoyment one gets from performing the activity, or the interest the individual has in the subject (similar to intrinsic motivation). *Utility value* is determined by how well a task relates to current and future goals (e.g., educational, family, and career aspirations), and captures the "extrinsic" reasons for engaging in a task. Finally, *cost* refers to the negative aspects of engaging in a task, such as performance anxiety, the amount of effort needed to succeed, and lost opportunities that result from making one decision over another (Eccles et al., 1998).

Wigfield and Eccles (2000) suggest that interest, or the intrinsic component of value, may be especially salient during early elementary school when children's activity choices are directly related to their interests. Young children are likely to be interested in everything, and try many different activities before developing more stable opinions regarding the activities they enjoy the most. As individuals reach adolescence and develop more stable self-schemas and long-range goals and plans, the perceived utility and importance of various tasks becomes more important to the development of values (Wigfield & Eccles, 2000). Thus, in the current study, it was expected that individuals' reports of utility value (i.e., how well computer activities relate to future educational goals) would be important predictors of future career aspirations.

In addition to expectations for success and value, research (e.g., Bae & Smith, 1996; Catsambis, 1999; Jones et al., 2000) examining the expectancy-value model of achievement motivation also focuses on the importance of activities and experiences during adolescence as being precursors of later beliefs and occupational aspirations. The model predicts that adolescents who spend less time on certain activities (e.g., science experiments, computer games) have less interest in these areas and view them as less useful to their lives, compared to adolescents who spend much time in these activities (see Bandura, Barbaranelli, Vittorio-Caprara, & Pastorelli, 2001; Eccles et al., 1998).

In summary, Eccles and colleagues' (1983) expectancy-value model of achievement motivation links achievement-related choices, such as career goals, to individuals' expectations for success and the importance or value an individual attaches to a domain. Specifically, the model assumes that achievement-related choices are guided by one's expectations for success and self-efficacy, the value the individual places on a domain, and the activities in which one is involved (Eccles et al, 1998). The current study applied the expectancy-value model of achievement motivation to the domain of computers and technology, and hypothesized that adolescents' expectations for success, gender stereotypes, computer utility values, and computer activity-involvement would be related to career beliefs.

Although women have been historically underrepresented in math and science, the gender gaps in mathematics and many areas of science, such as biology and medicine, are beginning to close. Compared to the 1990's, more girls are now taking algebra and geometry. On average, females consistently earn equivalent or higher grades than males in many of these subjects throughout their educational experience (Catsambis, 1999; Hyde, 1997; NCES, 2001b). Young women are also majoring in math and many science fields at higher rates than ever before. However, obstacles still remain for females in computer-related fields. Girls often report less interest in fields such as computer science and other areas of technology, and the vast majority of women do not consider these fields when thinking of future career plans (Bandura et al., 2001).

In fact, the number of women entering computer science courses has dropped steadily over the past decade. In Canada, undergraduate full-time enrollments in computer science have declined for women as a proportion of total full-time computer science enrollment from 27 percent in 1982 to 20 percent in 1992 (Dryburgh, 2000). Similarly, in the United States, the number of BA/BS degrees in computer science awarded to women between 1983 and 1995 decreased by 23.5 percent (Gurer, 1998). Moreover, Levine (2002) reports that the percentage of doctorate degrees awarded to women in computer science in the United States declined from 17.5% in 1988-1989 to 16% in 2000-2001. Thus, drawing on past findings from the domains of math and science, research is now needed to explore possible reasons for the continuing gender gap in IT.

Empirical Research on Gender Differences in Math and Science

Numerous empirical studies within the domains of math and science have demonstrated the enduring links between expectations for success, value, interest, activity-involvement, and later educational and career choices. Moreover, such studies have uncovered interesting gender differences in math and science beliefs and behaviors, helping to explain the gender gaps in math and science career choices. Even though these studies have focused on the broad domains of math and science, and most analyses have not examined the specific domain of computer technology, findings from math and science can be used to guide further research on gender differences in computer science. Similar to math and science, educational achievement in the domain of computer technology, especially at advanced levels, involves analytical skills, logical reasoning, and systematic thinking. Moreover, much like math and science, the domain of computer technology has been historically gender-stereotyped in favor of males (see Dryburgh, 2000).

Expectations for Success

Most evidence suggests that although the gap between boys’ and girls’ ability levels in math and science has decreased substantially since the early 1980's, with girls outperforming boys in some cases, girls still report lower self-efficacy and self-perceptions in math and science, often greatly underestimating their abilities (Heller & Ziegler, 1996; Jacobs, 1991; Jacobs & Eccles, 1992; Juang & Silbereisen, 2002; Pajares, 1996). For example, Meece and Jones (1996) found no gender differences in fifth and sixth grade students' science grades or standardized test scores, but girls reported less confidence than boys in their ability to perform well on science tasks in the classroom. Moreover, a recent study showed that adolescents' self-perceptions of math ability during high school predicted their math/science career self-efficacy during young adulthood, even after controlling for actual ability level; boys in this study reported higher self-perceptions of math ability during high school, and were more likely than girls to indicate high self-efficacy for math/science careers four years later, even though the actual ability levels of boys and girls were not significantly different (Bleeker & Jacobs, 2004).

Several other studies provide evidence suggesting that an individual's self-perception of ability is related to career choice more than an individual's actual ability (e.g., Eccles & Wigfield, 1995; Farmer, Wardrop, & Rotella, 1999; Meece, Wigfield, & Eccles, 1990). For instance, the girls and boys in Catsambis's (1999) study had similar mathematics test scores and grades in the eighth grade. However, female students had less confidence in their math abilities than did male students and were significantly less likely than male students to indicate mathematics when describing their career aspirations when in the 10th grade. Similarly, within a group of 1990 high school seniors who scored above the 90th percentile on the mathematics portion of the Scholastic Aptitude Test, females were only two-thirds as likely as males to indicate plans for pursuing a career in science or engineering (Matyas & Dix, 1992).

Bandura and colleagues (2001) suggest that gender differences in occupational choice follow stereotypic courses, with boys judging themselves more efficacious for careers in science and technology, and girls reporting higher efficacy for social, educational, and health service jobs (Bandura et al., 2001). Research findings show that girls are catching up with boys, and in some cases surpassing them in math and science coursework during high school, but girls are still avoiding careers in some scientific and technical fields. Such findings suggest that the foreclosure of career options may be due to perceived inefficacy, rather than poor background preparation (Bandura et al., 2001).

These findings provide support for the Eccles et al. (1998) expectancy-value model of achievement motivation, by illustrating the importance of expectations for success. Indeed, this research suggests that individuals are more likely to become involved in activities and choose careers in certain domains when they feel a high level of efficacy.

Value/Interest

As mentioned above, Eccles, Barber, and Jozefowicz (1998) suggest that female students' career decisions are not entirely due to self-efficacy, or an issue of "foreclosure" as Bandura and colleagues suggest, but also have to do with the *value* these students place on having a job associated with people and humanistic concerns. Although physical sciences are often rejected by girls because they cannot make important links between these subjects and what they care about (Burkam, Lee, & Smerdon, 1997), biology and other life sciences have traditionally been viewed by girls as more interesting and caring branches of science that focus on living organisms and human health (Jones at al., 2000).

Indeed, Eccles, Barber, and Jozefowicz (1998) found that female students who chose science-related or health careers expected to do better in science-related occupations than females who did not choose these careers. However, the value of "people-society job characteristics” differentiated females who chose health careers from those who chose other science-related careers. Females who aspired to health careers placed high value on people and society-oriented jobs, whereas female students who aspired to other science-related careers placed unusually low value on people-society job characteristics (Eccles, Barber, & Jozefowicz, 1998). Both of these sets of females expect to do well in science-related jobs; thus, it appears as though female students’ decisions to go into science versus health-related fields is not merely a science-related efficacy issue, as Bandura and colleagues (2001) suggest, but also has to do with the value these students place on people and humanistic concerns.

Similarly, in a recent study of college students, women who were majoring in science reported that were more likely to persist in their major when they felt the subject they were studying was relevant to their personal values, including improving social conditions for others (Farmer et al., 1999). Thus, increased emphasis on the humanistic and people-oriented aspects of science-related careers is an important part of encouraging more girls and women to pursue careers in the sciences. Also, as predicted by the Eccles et al. (1998) expectancy-value model, as individuals reach adolescence and develop more stable self-schemas and long-range goals and plans, it seems that the perceived utility and importance of various tasks becomes more important to the development of values and goals for the future (Wigfield & Eccles, 2000).

Activity Involvement

Other research (e.g., Bae & Smith, 1996, Catsambis, 1999; Jones et al., 2000), consistent with Eccles et al.’s (1998) expectancy-value model, has focused on the importance of activities and experiences during adolescence as being precursors of later beliefs and occupational aspirations in math and science. These studies show that boys are more likely than girls to participate in mathematics and physical science-related activities; specifically, boys have more extracurricular experiences that are related to the physical sciences and are more likely than girls to have conducted their own science experiments. Adolescent girls, however, have similar, or in some cases, more experience than boys in biology-related activities experiments. These types of activities are related to later career goals and educational decisions (e.g., Bae & Smith, 1996; Catsambis, 1999; Jones et al., 2000).

Therefore, in addition to expectations for success and value, empirical research also demonstrates the importance of activities and experiences during adolescence as being precursors of later beliefs and occupational aspirations, once again providing support for the expectancy-value model of achievement (Eccles et al., 1998).

Empirical Research on Computers and Technology

Eccles and colleagues' (1983) expectancy-value model of achievement motivation suggests that adolescents' attitudes (e.g., expectations for success, utility values) and activity-involvement predict later career plans. As described above, findings from past research in the domains of math and science illustrate this model and suggest that individuals base their educational and career plans on expectations for success, value/interest, and activity-involvement. Thus, in order to understand the current gender gap in computer-related career choices, the present study investigated gender differences in adolescents' computer-related expectations for success, utility value, and activities.

Expectations for Success

Research about achievement in the domain of computer technology has assessed overall gender differences in students' computer beliefs, including variables similar to what Eccles calls "expectations for success" or "self-perceptions of ability." Although female college freshman have significantly closed the gender gap in computer use, there is still an overwhelming gender difference in computer confidence levels between male and female students (Dickhauser & Stiensmeier-Pelster, 2002; Nelson & Cooper, 1997; Sax, Astin, Korn, & Mahoney, 2000; Shashaani, 1995; Woodrow, 1994). In fact, a considerable body of empirical research on computer-related attitudes suggests that females hold less positive attitudes than males among samples of elementary schools students (Todman & Dick, 1993), high school students (Kirkman, 1993; Okebukola, 1993; Shashaani, 1993), and undergraduate students (Colley, Gale, & Harris, 1994). There is almost a complete absence of studies suggesting that females have more positive computer-related attitudes and expectations for success than males (Francis & Katz, 1996).

This gender gap in computer-related ability beliefs first appears in the elementary school years and widens as students move through middle and high school, into college and beyond. In the early grades, males and females demonstrate more similar attitudes about computers. As females advance through middle, secondary, and postsecondary grades, their expectations for success drop and they become under-represented in computer science courses, despite the fact that girls are over-represented in computer applications courses such as word processing and data management (see Burge, 2001). By the time adolescents graduate from high school, the gender gap in computer attitudes is striking, with males reporting more positive attitudes toward computer technology than females (Kirkpatrick & Cuban, 2000).

Alarmingly, while the gender gap in computer confidence has always favored males, the gap among the 2000 college freshman class is actually the *largest* in the history of the UCLA's ongoing survey. First year college women and men reported almost equal computer use, but female freshman were only half as likely as men to rate their computer skills highly. Only 23% of women, compared with 46% of men, rated their computer skills as "above average" or "within the top 10 percent" of people their age (Sax et al., 2000). In another study, females were more likely to consider themselves “not the type to do well with computers,” and less likely to say they “could handle a more difficult computer course” (Young, 2000). The gap in self-confidence may contribute to the fact that men are five times more likely to pursue careers in computer programming (9.3% of men, versus 1.8% of women). “In a workforce increasingly dependent on technological proficiency, women’s relative lack of computer confidence is likely to place them at a disadvantage when it comes to the jobs they are willing to seek out,” argues Linda Sax, UCLA Education Professor (Sax et al., 2000).

In addition to having lower computer self-concept of ability and expecting less success with computers, girls report less favorable attributions for computer success and failure (Dickhauser & Stiensmeier-Pelster, 2002). For instance, in a recent experimental study, boys and girls had different reactions to the success and failure of computer programs, and most of these differences could be accounted for by gender differences in attributions and perceived competence. Boys in the study felt more relaxed than girls while using computer programs, and this gender difference was completely accounted for by gender differences in frequency of previous computer use and perceived competence with computers. In comparison to girls, boys also expected to do better if given a chance to use a computer program (Nelson & Cooper, 1997). Moreover, boys who experienced failure attributed it to lack of effort, bad luck, or other unstable external causes, rather than to their own lack of ability. Girls, however, were likely to attribute *success* with computer programs to external causes (e.g., program-specific attributions), rather than to their own ability, and attributed failures to lack of competence (see Dryburgh, 2000; Nelson & Cooper, 1997).

Research within the domain of computers and technology has also assessed gender differences in computer anxiety. Although computer anxiety has decreased throughout the past decade among males and females, gender differences still exist in individuals' reports of computer anxiety (Chua, Chen, & Wong, 1999). In fact, the overall reduction in computer anxiety during the past 10 years has actually concealed a widening gender gap between the average computer anxiety scores of male and female college students, with female representation in the high anxiety group actually increasing from 1992 to 1998 (Todman, 2000). Studies suggest that computer anxiety is negatively related to computer experience (Chua et al., 1999); thus females who have less experience tend to demonstrate higher levels of anxiety than males (Ayersman, 1996). However, even as the gender gap in computer usage and experience decreases, the gender gap in anxiety endures.

There also seems to be a tendency for individuals to report general gender stereotypes about computers and computer-users. Overall, boys are more likely to hold gender stereotypes about computers than girls, and these sex-stereotypes beliefs increase with computer experience (see Dryburgh, 2000). Almost half of the female undergraduate students in Francis and Katz's (1996) study reported that men are better at using computers than women. Interestingly, women's beliefs about their own computer abilities were not related to their gender stereotyping of computers.

Recent research on this topic, however, has produced mixed results. For instance, other studies have shown that there is a tendency for women to be unsure of their own individual ability to use computers, while at the same time believing that women in general are as capable as men when learning how to use the computer (Shashaani, 1993; Makrakis, 1993). Still other research points to a more direct relationship between gender stereotypes and ability beliefs, suggesting that less positive attitudes towards computers are associated with gender stereotypes (Francis, 1994), such that girls with more traditional gender stereotypes are more likely to have less positive attitudes about technology.

Nevertheless, empirical research in this area clearly demonstrates the existence of gender differences in expectations for success with regard to computers and technology. To summarize, in comparison to men, women report less positive computer-related attitudes, lower levels of self-confidence, are more likely to attribute failures to lack of ability, and report higher levels of computer anxiety (Dickhauser & Stiensmeier-Pelster, 2002; Sax et al., 2000; Todman, 2000). Moreover, it appears as though women's gender stereotypes about computers are associated with their own expectations for success in the domain (Francis, 1994). These empirical findings correspond with Eccles and colleagues' (1983; 1998) expectancy-model of achievement motivation and provide some initial support for applying the expectancy-model of achievement motivation to the domain of computers and technology.

Value/Interest

Gender differences in computer value and interest have also been found, especially during adolescence. In past research, most studies reported small gaps in computer attitudes between males and females in elementary school; however, by the time students graduate from high school, the gender gap in computer attitudes is significantly larger with males revealing more positive attitudes toward technology (Kirkpatrick & Cuban, 2000). In fact, while boys and girls may begin school with similar interests and attitudes for computers, as children move through elementary grades and into middle school and high school, girls tend to show less interest in computers than boys (Levin & Barry, 1997; Liao, 1999; Shashaani, 1994; Shashaani, 1995); the largest gender differences in computer interests and values are obtained during the high school years (Whitley, 1997). For instance, ninth-grade males show more positive attitudes toward computers than females, even when computer experience is controlled (Kadijevich, 2000), and male students are more likely than female students to enroll in high school computer classes, perhaps indicating higher levels of utility value for boys than girls (AAUW Educational Foundation, 1998).

According to gender and computer experts such as Jane Margolis of the Carnegie Mellon Project on Gender and Computer Science, as females get older, they begin to attach their interests in computing to the people-oriented social context of computers. Females are most interested in computers when they can see the relations between computer technology and social contexts, because they value jobs that allow them to make a difference in society (Margolis & Fisher, 2003). Thus, not surprisingly, in contrast to men, most young women who choose to major in computer science typically enter the field because of more applied purposes, rather than choosing computer science simply because of their love for programming or technology (Stabiner, 2003). Unfortunately, girls often fail to see the high tech industry as a key to the idealistic path pf helping others or making a contribution to society.

Moreover, many adolescents choose to pursue occupations other than those in technology because they are unable to relate their everyday interests in computers to careers in technology (see Dryburgh, 2000). For instance, lack of interest or value in pursuing computer science degrees is related to stereotypical perceptions of computer scientists (McDonald, 2004). Even though some adolescents spend more than 16 hours each week in front of a computer (Rideout et al., 1999), many express negative views about programming work, and have a general aversion to the field of computer science. Computer scientists are stereotyped as male, very smart, antisocial, and content to sit in front of a computer for long hours. Consequently, computing careers are perceived as involving little human contact, consisting mostly of keyboard work, and lacking in creativity (see Dryburgh, 2000). These job characteristics associated with computer science seem to be especially unattractive to girls (Gilbert, 2002).

In fact, older adolescent females may show less positive attitudes toward computers overall because they are, compared to males, less interested in computers as a career and probably see them as less important or valuable to their educational and career plans. Females perceive computer programming as a narrowly defined occupation and may be turned off to the notion of computer programming careers as isolated cubicle-bound jobs. According to Allan Fisher, former dean of computer science at Carnegie Mellon University, "although computing career interests in men are seeing a real resurgence, we are seeing much less of a resurgence in women. There is a much stronger negative public perception of what computer programming is like. That stereotype tends to be more deterring to women than men" (Mayfield, 2001).

Despite this possibility, research has not yet focused on gender differences in the relation between students' computer activities and their opinions about the importance or value of computer science and computer-related career goals (Kadijevich, 2000). Research has also failed to look more closely at different types of careers within technology. For instance, based on Eccles, Barber, and Jozefowicz's (1998) work showing the importance of girls' valuing of "people-society job" characteristics within the domains of math and science, it seems that females would be likely to value certain careers in technology (web development, technology assistance) more than others (programming). Research, however, has failed to look more closely at various types of careers within technology; most studies (e.g., Kadijevich, 2000) have asked only about computer science careers, or have simply asked adolescents to estimate how often they might use computers in their future careers.

In spite of the limitations of past research, the empirical research that has examined gender differences in computer-related values corroborates Eccles and colleagues' (1983; 1998) expectancy-value model of achievement motivation. It appears as though females place less emphasis and value on learning about computers during adolescence, and probably see computers and technology as less important or valuable to their educational and career plans, in comparison to their male counterparts (Mayfield, 2001). Importantly, most researchers involved in computer research agree that the basis of such gender differences in computer attitudes is essentially cultural and not related to inner ability (see Shashaani, 1994). Females may simply value computers less than males, beginning in childhood (Kadijevich, 2000), and these early gender differences in computer attitudes likely preface the persistent under-representation of women in IT professions.

Activity Involvement

Until recently, most research has suggested that males spend more overall time using computers than females (e.g., Shashaani, 1994; Woodrow, 1994). Although the majority of current research indicates that these gender differences are decreasing, some recent research still uncovers such gender differences in overall time spent on the computer. For instance, one recent study found that females report using computers less often, with less enthusiasm, and differently than males (see Burge, 2001). Males also report more experience with computers, are more likely to have taken high school courses requiring computer use, and generally report higher skill levels compared to females on applications such as programming, games, and graphics (Schumacher & Morahan-Martin, 2001). Not surprisingly then, female undergraduates who choose to pursue computer science enter computer science departments with less hands-on experience than their male counterparts. Although there is generally no difference in computer ability, this difference in experience often leads to gender differences in confidence during training (Gilbert, 2002).

Even though some studies still find an overall gender difference in computer use, most recent research shows that time spent on computers has become more similar for male and female adolescents (e.g., Sacks & Bellisimo, 1994; Sax et al., 2000). For instance, even though Rocheleau (1995) found gender differences in computer use favoring boys during the first four years of a study examining computer use among middle school students, by the fifth year of the study, gender differences in computer use were no longer significant.

Male and female adolescents, however, seem to spend their computer time on different sets of activities. Generally, it has been suggested that boys are more likely to see the computer as a playful toy, whereas girls see the computer as a tool (Giacquinta, Bauer, & Levin, 1993). For instance, most research suggests that females spend less time than males on the Internet and playing computer and video games, especially at older ages (Griffiths, Davies, & Chappell, 2004; Mayfield, 2001; Sax et al., 2000; Wright et al., 2001). Among college freshman, 35.4% of men reporting playing games for three or more hours per week, compared to only 9.6% of women (Sax et al., 2000). Recent findings, however, are not entirely clear. Although Mumtaz (2001) found that boys spent more time playing computer games, the girls in their study spent more time on the Internet and emailing friends than boys. Yet, among another recent sample, girls were more likely to use chatrooms, and boys were more likely to use email and Internet applications (Kafai & Sutton, 1999). Some studies have shown that girls use computers more at school than boys, for activities such as word-processing (e.g., Cole, 2000), while other research finds no overall gender differences in word processing among high school students (Sacks & Bellisimo, 1994).

The important question is probably not about how much time boys and girls spend on activities, but instead whether boys' and girls' activities are differentially associated with their beliefs about computers and technology, IT careers, and achievement in IT domains. For instance, perhaps certain computer activities (e.g., chatting, emailing, webpage development) are more highly associated with human contact, helping girls to value technology more than activities such as game-playing and programming. Computer programming, however, may be more strongly related to boys' career aspirations in technology than activities such as web surfing and spending time conversing in chat rooms. Unfortunately, past research has not examined the different relations between specific computer activities (e.g., webpage development vs. programming), gender, and adolescents' computer attitudes and technology-related career goals.

Even though research has failed to provide a clear and detailed description of how adolescents use current computer technology, past research has examined general relations between computer activity-involvement and computer attitudes. In accordance with Eccles and colleagues' (1998) expectancy-value model, this research usually concludes that computer experience seems to strongly influence the development of positive attitudes toward the use of computers (Mitra & Steffensmeier, 2000; Shashaani, 1994; Woodrow, 1994). For instance, students who use computers regularly develop more positive attitudes towards computers and less computer anxiety (McIlroy, Bunting, Tierney, & Gordon, 2001).

Interestingly, some research in this area suggests that the relationship between computer use and beliefs may be different for males and females. For example, Woodrow's (1994) results suggest that the computer attitudes of males were more sensitive to the effects of experience than were those of females. On the other hand, Sacks and Bellisimo (1994) reported that although computer use was unrelated to boys' beliefs, time on the computer helped girls develop more favorable attitudes towards computers. Finally, computer experience was associated with positive computer attitudes for girls and associated with more gender traditional views of the computer for boys (see Dryburgh, 2000).

In summary, researchers who study the motivational and social factors that influence males' and females' achievement goals, behaviors, and career beliefs have empirically illustrated several important factors that account for gender differences in later achievement and career choices. Specifically, empirical studies within math and science, and to some extent within the field of technology, have demonstrated the enduring links between expectations for success, value/interest, activity-involvement, and later educational and career choices. Moreover, such studies have uncovered interesting gender differences in beliefs and behaviors, helping to explain some gender gaps in career choice. Previous research, however, has not attempted to relate specific computer activities, attitudes, or combinations of activities and attitudes to career-related beliefs or goals within the broad field of computer technology. Moreover, past research has not examined the relation between gender, activities, attitudes, and *specific* types of computer careers (e.g., computer scientist vs. webmaster).

Limitations of Measures Used in Past Research

Three main limitations exist in the research literature with regard to the measurement of adolescents' computer activities and attitudes. First, as described earlier, research has failed to look closely at various types of careers within technology. Most studies (e.g., Kadijevich, 2000) have asked only about computer science careers, or have simply asked adolescents to estimate how often they might use computers in their future careers. Unfortunately, these questions lack specificity and do not accrue much-needed information on adolescents' views about the many different types of careers within the broad IT workforce. The current study attempts to move beyond these limitations by asking adolescents to report their interest and efficacy for various careers within the computer and technology workforce, rather than only asking about computer science.

Moreover, given the current trends of frequent computer use among adolescents, many of the scales and items used to measure adolescents' computer attitudes (e.g., self-confidence, value) in past research now seem outdated. For instance, in the past, computer expertise, or self-perceptions of confidence, were measured with items such as, "It would be hard for me to learn to use a computer" (Levine & Donitsa-Schmidt, 1997). Similarly, computer value has been measured with items such as, "Learning how to use a computer can help me" (Riggs & Enochs, 1993). Because the majority of adolescents are highly computer-literate and use computers daily (Debell & Chapman, 2003; Ubois, 2002), it seems unlikely that these items continue to be good measures of computer self-confidence or value. The current study improves on these measurement-related limitations of past research. Specifically, in order to more accurately capture adolescents' computer expertise and computer value, two new measures were developed through modification of a previously-used measure, the Computer Attitudes and Self-Confidence Questionnaire (Levine & Donitsa-Schmidt, 1997). New items are more consistent with current uses of technology and assess specific computer beliefs. In addition, these items ascertain information about *how* adolescents' use various applications and programs.

Finally, past research examining gender differences in computer activity-involvement has dichotomized computer use into two areas: 1) using the computer as a tool for applications (e.g., word processing), and 2) spending time playing games and/or programming computer applications (Giacquinta et al., 1993). This dichotomous classification has become too simplistic, especially when trying to understand how specific computer activities and attitudes may be related to career goals. As computers become increasingly ubiquitous and necessary in adolescents' lives, and as computer use spreads beyond the activities of game-playing and word-processing, this traditional notion of computer use needs to be expanded. Therefore, in addition to asking about several traditional types of computer activities (e.g., games, programming, word-processing), the current study also asks participants to report time spent on other activities (e.g., blogging, instant-messaging, helping friends and family with computer problems).

In summary, the current study goes beyond the limitations of past research in three ways. First, in order to attain a more complete picture of adolescents' levels of interest and efficacy for careers in technology, the current study includes items about various IT careers, rather than simply asking about computer science. Additionally, in order to more accurately capture the breadth of adolescents' current computer attitudes, two new attitudinal measures were developed to measure computer expertise and computer value. And finally, in order to understand different patterns of computer activities, the current study included a wider range of activity-related questions and used analyses to delineate between several distinct groups of adolescents.

Current Study

The current study examines gender and grade-level differences in adolescents' computer-related career beliefs and motivational factors, such as computer activity-involvement and attitudes, and investigates the relations between such factors. The present study also delineates between several distinct groups of adolescents, based on their computer activities, in order to understand how different patterns of computer use may be related to computer-related career beliefs. The specific research questions are:

1. Do adolescents' computer activities, attitudes, and beliefs about careers differ by gender and by grade?

2. Are adolescents' computer activities and attitudes related to their computer-related career beliefs, as would be expected by the Eccles et al. (1983, 1998) expectancy-value model of achievement motivation? Does sex moderate the relation between computer attitudes and computer-related career beliefs?
3. Are there individual differences in adolescents' computer activities (e.g., games, email, Internet research)? Can distinct groups or clusters of adolescents be identified, and do they vary by adolescents' sex and grade?
4. If distinct patterns or groups are identified, do particular patterns of computer activities relate to adolescents' career goals? Do gender and grade-level moderate this relationship?

The research questions in the current study are guided by application of Eccles' and colleagues (1983) expectancy-value model of achievement motivation to the domain of computers and technology. Generally, the model assumes that achievement-related choices, such as career beliefs, are guided by one's expectations for success, the value the individual places on the domain, gender beliefs, and the activities in which one is involved (Eccles et al., 1998). The specific constructs from the model that were examined in the present study, namely *activity-involvement, outcome expectancies, self-confidence, interest, computer value, and gender stereotypes*, have been empirically defined as strong predictors of career plans in other gender-stereotyped domains, such as math and science, especially during the period of adolescence under study. Past research has discovered that gender often moderates the relationships between these specific constructs and achievement-related choices in gender-stereotyped domains, especially as adolescents finish high school and begin planning for their future careers. Moreover, as illustrated in the review of literature above, interesting gender differences have been demonstrated in recent computer technology-related research, suggesting possible associations between these specific constructs (e.g., activity-involvement, self-confidence, interest, computer value, and gender stereotypes) and career plans in the gendered field of computer technology.

This specific set of constructs has been highlighted in Eccles and colleagues' (1983) comprehensive model (see Appendix A, Figure 2), and the specific theoretical model under study is displayed in Figure 3. The current study examines pathways relating computer activity-involvement and attitudes to computer-related career beliefs. The expectancy-value model predicts that adolescents' outcome expectancies, self-confidence, interest, and computer value will be positively associated with computer-related career beliefs, and that value will be a stronger predictor of career plans for girls than for boys. Past research applying Eccles' expectancy-value model (e.g., Eccles et al., 1998) has validated this pattern, demonstrating that adolescents' interpretations (i.e., attitudes) of their behaviors, and their actual activities (computer activity-involvement) are strong predictors of later achievement-related choices (i.e., career beliefs). Specific hypotheses are described in more detail below.

Research Questions and Specific Hypotheses

1. Do adolescents' computer activities, attitudes, and career plans differ by gender and by grade?

Specific Hypotheses:

a. There will be gender differences in computer activity-involvement, such that boys will be more likely than girls to indicate involvement with computer games, programming, and fixing computers. Based on previous research, it is expected that girls will be more likely than boys to indicate involvement with several

Internet-based applications (chat rooms, writing emails, and instant-messaging) and word processing software. Gender differences on all other computer activities are unknown but will be explored.

b. Based on prior research in the domains of math, science, and computer technology, it is hypothesized that gender differences will exist with regard to computer attitudes, such that girls will report lower levels of computer value, lower outcome expectancies, less traditional gender stereotypes, and lower self-confidence than boys, but higher levels of computer anxiety.

c. Based on prior research about the development of career beliefs, grade level differences in computer value are expected, such that 12th graders will report higher levels of value than 9th graders.

d. The relation between grade-level and computer activities, computer anxiety, self-confidence, gender stereotypes, and outcome expectancies are unknown but will be explored. Past research does not provide a clear picture of age-related differences in these constructs within the domain of technology.

e. Grade-level X gender interactions in the above relationships are unknown but will be explored. Previous research has not systematically examined the interaction of grade level and gender on computer attitudes and activities. But, based on empirical research from the domains of math and science, it is expected that gender differences in value and computer outcome expectancies will be larger for 12th graders than 9th graders, with boys rating value and outcome expectancy higher than girls.

f. Based on the current gender gap within the computer science workforce, it is expected that boys will report higher likelihoods of entering computer-related careers than girls; boys will also indicate higher levels of interest and ability in computer-related careers than girls. More specifically, based on past research that has uncovered gender differences within the broad domain of science, it is expected that these gender differences in computer-related careers will be less evident with "people-centered" and more applied careers in computer support service, data administration, computer teaching, and web development, and more evident with careers as computer scientists, computer analysts, and webmasters.

2. Are adolescents' computer activities and attitudes related to their computer-related career beliefs, as would be expected by Eccles et al. (1998) expectancy-value model of achievement motivation? Does adolescents' sex moderate the relation between computer attitudes and computer-related career beliefs?

Specific Hypotheses:

a. Computer attitudes will be related to computer career beliefs, but this relationship will be moderated by adolescents' sex.

i. Based on past research within the domains of math and science, positive associations between outcome expectancies, interest, self-confidence, computer value and computer-related career beliefs are expected; value will be a stronger predictor of career plans for girls than for boys.

ii. Based on past research within the gender-stereotyped domains of math and science, gender stereotypes are expected to have a positive relation with computer career beliefs for boys, but will be negatively related to career beliefs for girls.

b. Computer activity-involvement will be positively related to computer-related career beliefs.

c. Based on past empirical research testing the influence of predictors in Eccles and colleagues model, it is expected that computer attitudes will be positively related to computer-related career beliefs, and computer activities will add a significant positive contribution to this relationship when added into the regression equation.

3. Are there individual differences in adolescents' computer activities? Can distinct groups or clusters of adolescents be identified, and do they vary by adolescents' sex and grade?

Specific Hypotheses:

a. A minimum of 3 distinct clusters of adolescents will be identified, based on patterns of computer activities. Although is it impossible to predict the nature of the clusters, the following examples illustrate the types of combinations expected:

- Cluster 1: high game-playing, high programming, low email, low word processing
- Cluster 2: low game-playing, low programming, high email, high word processing
- Cluster 3: average game-playing, low programming, high email, average word processing

b. Based on past research that has looked at gender differences in computer activities it is expected that clusters will vary by sex, such that some clusters (cluster 1 above) will be more likely to be composed of male participants, whereas other clusters (cluster 2) will have higher concentrations of female participants.

4. If distinct patterns or groups are identified, do particular patterns of computer activities relate to adolescents' career goals? Do gender and grade-level moderate this relationship?

Specific Hypotheses:

a. Based on past research in the area of math/science, it is expected that some computer activity clusters (for example, cluster 1 above) will be more strongly related to IT career beliefs than others; this relationship will be moderated by adolescents' sex. The direction of the moderated relationship is unknown.

Method

Participants

During the fall semester of 2004, student participants (n = 460) were recruited from two high schools in central Pennsylvania. The first high school (HS 1) was a public school with a total of 2616 enrolled students, located in a mid-sized city with a median family income of $60,527 (primarily middle/lower-middle class). The second high school (HS 2), also a public school, had a total of 525 enrolled students and was located in a rural community with a median family income of $52,083 (U. S. Census Bureau, 2000). Both HS 1 and HS 2 are the only high schools located in their respective communities.

The sample from HS 1 consisted of 378 students (171 girls, 207 boys) in grades 9 – 12.

Students were recruited from math, world history, sociology, and chemistry courses. Although students in HS 1 represented grades 9 through 12, the majority of students (82%) were in the 9^{th} or 12^{th} grade at the time of data collection. The sample from HS 2 consisted of 82 students (42 girls, 40 boys) from grade 9. Students in this high school were recruited from a mandatory freshmen-level computer technology course. This second high school was included in the study in order to increase the sample size and allow for between-school comparisons. At both high schools, an identical web-based survey was administered to students during class time in a computer lab. Although information about participants' racial/ethnic backgrounds was not collected in the current study, the majority of students enrolled in HS 1 and HS 2 were European-American (86% in HS 1 and 98% in HS 2; NCES, 2004).

A packet containing a cover letter, informational flyer, and passive informed consent form was mailed to parents' homes two weeks prior to data collection. These materials described the research project and asked parents to contact the principal investigator by phone or email if they wished for their child to be exempt. None of the parents contacted the principal investigator. Thus all students were eligible to participate in the study. On the days that the survey was administered, no students refused to participate. However, there was a small group of students who did not take the survey due to school absence or scheduling conflicts.

Procedure

Computer-based survey. Student participants reported to a computer lab and completed a web-based survey powered by Perseus Survey Solutions 6, during class time. Directions were read aloud to the class and students were asked to answer questions accurately and honestly. Participants were assured that their responses were confidential and completely anonymous. After reading and signing a student consent form, students were instructed to begin the survey.

The survey took students 20-40 minutes to complete. After students clicked a "submit" button placed at the end of the survey, answers were automatically and anonymously emailed to the survey administrator.

Measures

Demographics

Participants were asked to report demographic information such as sex, grade level, age, and GPA. These items were modeled after questions used with adolescents' in the past (Eccles et al., 1983). Although measures of family income were not included in the study (i.e., school administrators would not allow the question to be asked), this demographic section also asked participants to report the number of computers in their home, in order to get a measure of participants' computer access at home.

Computer Attitudes

Participants were asked to report their attitudes about computers and technology. First, participants were asked to report their attitudes about seven different computer-related careers. Next, participants answered questions assessing their computer anxiety, computer self-confidence, computer outcome expectancy, computer gender stereotypes, views about the compatibility between computer careers and family life, computer expertise, and computer value. The scales are described in detail below.

Computer-related Career Beliefs. Participants were asked to answer a series of three questions about seven different *computer-related jobs* (computer scientist, computer systems analyst, webmaster, web developer/designer, database administrator, computer support services, computer teacher), indicating their *level of interest* in the occupation, *likelihood of entering* the occupation, and *efficacy for* the occupation. The list of seven jobs included the technology and computer-related occupations listed on the U.S. Department of Labor's computer science webpage (Bureau of Labor Statistics, 2003). In order to help participants assess their beliefs about each occupation, a short description of each job was included, based on descriptions provided by the U.S. Department of Labor (Bureau of Labor Statistics, 2003; see Appendix B).

Items were answered using 7-point response scales, ranging from "not very" to "very" (see Appendix A, Table 1), and were based on items developed by Eccles and her colleagues in earlier studies to assess adolescents' career beliefs (see Eccles et al., 1983; Eccles & Wigfield, 1995; Eccles et al., 1993; Eccles-Parsons, Adler, & Kaczala, 1982). Items were aggregated across job types in order to create subscales measuring interest, likelihood, and efficacy. Specifically, three sub-scales, each consisting of 7 items, were created to measure *interest*, *likelihood*, and *efficacy* for computer-related jobs. The Cronbach's α coefficients for the interest, likelihood, and efficacy scales were .87, .90, and .91 respectively, indicating good internal consistency (see Table 1).

Computer Anxiety Scale. (CAS; Selwyn, 1997). This sub-scale of the Computer Attitudes Scale, developed by Selwyn (1997), consists of 6 items, and is answered with a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree" (see Table 2). Higher scores represent greater agreement with the statement. Negative attitudes were reversed for scoring purposes. The Cronbach's α coefficient for the scale was .88, indicating good internal consistency.

Computer Attitudes and Self-Confidence Questionnaire. (CASCQ; Levine & Donitsa-Schmidt, 1997). The original measure consists of 42 items, structured as statements, and is answered with a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree." Higher scores represent greater agreement with the statement. Negative attitudes were reversed for scoring purposes. This questionnaire was validated in the past (see Levine & Donitsa-Schmidt, 1997) with a sample of 7th – 12th grade students, using component factor analysis with varimax rotation. The CASCQ measures five different dimensions of computer attitudes: 1) Value; 2) Computer Stereotypes; 3) Computer Self-Confidence; 4) Interest; and 5) Enjoyment.

Thirty of the original 42 items from the CASCQ were included in the present study. The twelve items used to measure "computer stereotypes" were not assessed because they were deemed outdated and redundant with other measures used in the current study. Before creating the four individual scales (Value, Self-Confidence, Interest, and Enjoyment), a factor analysis was conducted, using varimax rotation. The results of the factor analyses suggested the existence of four factors, identical to those reported in previous studies (Levine & Donitsa-Schmidt, 1997), providing sufficient reasoning for creation of the four subscales used in the past. Four subscales were created and the Cronbach's α coefficient for each of the scales indicated good internal consistency (e.g., Value = .72; Self-Confidence = .85; Interest = .92; and Enjoyment = .74; see Table 3).

Computer Outcome Expectancy. (COE; Riggs & Enochs, 1993). This scale is part of the Microcomputer Beliefs Inventory, developed by Riggs and Enochs (1993), to measure the outcome expectancy beliefs of students toward computers. The scale consists of 13 items and is answered with a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree" (see Table 4). Higher scores represent greater agreement with the statement. Negative attitudes were reversed for scoring purposes. The Cronbach's α coefficient for the scale was .79, indicating good internal consistency.

Computer Gender Stereotypes. (Computer-Aptitude Gender Equity; Woodrow, 1994). This 5-item scale measures participants' attitudes toward males' and females' aptitudes on computer activities and has been used with adolescents in past research (see Woodrow, 1994). The items are answered with a 5-point Likert scale, ranging from “strongly disagree” to strongly agree” (see Table 5). Higher scores represent more traditional gender stereotypes with regard to computers. Negative attitudes were reversed for scoring purposes. The Cronbach’s α coefficient for the scale was .90, indicating good internal consistency.

Computer Careers and Family Compatibility. This 5-item scale measures participants’ attitudes toward the compatibility of family life and careers in technology/computers. Items were based on a measure used previously (Barber & Eccles, 2003). The items are answered with a 5-point Likert scale, ranging from “strongly disagree” to “strongly agree” (see Table 6). Higher scores represent greater agreement with the statement, and stronger views of compatibility. Negative attitudes were reversed for scoring purposes. The Cronbach’s α coefficient for the scale was .90, indicating good internal consistency.

Development of Two New Measures: Computer Expertise and Computer Value

In order to more accurately capture adolescents’ computer attitudes, two new measures (Computer Expertise and Computer Value) were developed in the present study. A series of 24 items was used to measure computer expertise, and 17 items were used to measure computer value, including questions used in previous research (Panero, Lane, & Napier, 1997; Selwyn, 1997; Valois, Frenette, Villeneuve, Sabourin, & Bordeleau, 2000; Zarrett & Malanchuk, 2004) and questions developed by the author to be more consistent with current uses of technology. These items are worded similarly to items used in the CASCQ (Levine & Donitsa-Schmidt, 1997), but are more in line with adolescents’ current computer use than measures used in past research. Consistent with the CASCQ, these items were answered with a 5-point Likert scale, ranging from “strongly disagree” to “strongly agree.” Higher scores represent greater agreement with the statements. Negative attitudes were reversed for scoring purposes.

The items for the Computer Expertise and Computer Value measures were pre-tested during the spring semester of 2004 with 8^{th} grade student participants (n = 218; 104 girls, 114 boys) at a middle school in central Pennsylvania. Student participants completed a paper-pencil survey in their math classrooms during school hours. The Computer Expertise and Computer Value items were positioned at the end of the survey.

The responses from participants involved in the pre-test were subjected to two separate factor analyses, allowing the Computer Expertise and Computer Value items to be assessed separately. Results of the first factor analyses (using promax rotation) using data from the pre-test study suggested that the Computer Expertise measure consisted of 4 subscales: Preferences (7 items), Troubleshooting (7 items), Need Help (4 items), and Give Help (2 items). The Cronbach's α coefficient for the Preferences, Troubleshooting, Need Help, and Give Help scales were .88, .84, .61, and .70, respectively. Results of the second factor analysis suggested that the Computer Value measure consisted of 3 subscales: Computer Affect (5 items), Communication (5 items), and Computer as a Tool (5 items). The Cronbach's α coefficient for the Computer Affect, Communication, and Computer as a Tool scales were .88, .72, and .82, respectively.

These measures were refined and furthered developed in the current study, using data from the HS 1 and HS 2 samples. Based on the results of the pre-test described above, several items were re-worded for clarification or deleted from the measures, before being included in the current study. Additional items were also created and added to subscales with too few items. These refined items were included in the web-based survey given at HS 1 and HS 2.

Factor analysis, using promax rotation was used to assess patterns among the computer attitude items (Computer Expertise and Computer Value), and subscales were then created.

Promax Rotation, an oblique rotation, was used because this type of rotation allows factors to be correlated. The final scales and Cronbach's α coefficient's are shown in Table 7 (Computer Expertise) and Table 8 (Computer Value), and are described here:

Computer Expertise. A series of 24 items was used to measure Computer Expertise. Participants' responses to these items were subjected to a factor analysis (see Appendix C). Following the factor analysis, four subscales were created, and Cronbach's alphas were computed for each scale (e.g., Preferences = .85, Troubleshoot = .83, Need Help = .75, Give Help = .83; see Table 7).

Computer Value. A series of 17 items was used to measure computer value. Participants' responses to these items were subjected to a factor analysis (see Appendix D). Following factor analysis, four subscales were created, and Cronbach's alphas were computed for each scale (e.g., Computer Affect = .80, Communication = .77, Computer as a Tool = .83, Geeks Gadgets Greed =.74; see Table 8). Although the Geeks Gadgets and Greed scale was created as part of the factor analysis, this scale was not included in the current study.

Computer Activity-Involvement

Participants were also asked to respond to a series of questions that assessed their computer activities at home and school. Two identical sets of questions were used to assess the time participants spent on computer activities during *weekdays* and during the *weekend*. The responses to the *weekdays* and *weekend* activity questions were highly correlated (r = .70-.83); thus, in order to simplify analyses and decrease redundancy, the current study will focus entirely on responses about activities during weekdays.

Computer activities. This series of items included questions about overall time spent on the computer, time spent on miscellaneous computer tasks (e.g., word processing, educational programs, computer programming), school-related computer activities (including number of computer courses), computer games, and Internet activities (see Table 9). Although most of these questions were developed by the author for use in the current study, the format used was similar to questions used in other recent studies about adolescents' computer use (see Kafai & Sutton, 1999). Items were answered using a 6-point Likert-type scale ranging from *none* to *7+ hours*. Prior to analyses, variables were recoded in the following manner: (none = 0, less than 1 hour = 0.5, 1-2 hours = 1.5, 3-4 hours = 3.5, 5-6 hours = 5.5, 7+ hours = 7). Following recoding, the six computer game activities were added together to create a variable for total time spent playing computer games.

Results

After conducting preliminary analyses to create new measures and validate scales used in previous studies, four main sets of analyses were conducted to answer each of the four research questions. The first set of analyses was purely descriptive in nature, and assessed school, gender, and grade-based differences in computer attitudes, activity-involvement, and career beliefs. Second, the relation between adolescents' computer attitudes, computer activity-involvement, and computer-related career beliefs was investigated, with close examination of the interaction of sex with computer attitudes. Third, cluster analyses were conducted to examine individual differences in computer activities and delineate between several distinct groups or clusters of adolescents. Finally, the relationship between cluster membership, adolescents' sex, and computer-related career beliefs was assessed.

Research Question 1. Are there gender and grade-based differences in computer activity-involvement, attitudes, and career beliefs?

This section included simple, descriptive analyses examining gender and grade-based differences in computer activity-involvement, attitudes, and career beliefs. This section is *not* meant to provide any explanations for gender or grade-based differences, but is included simply to provide a snapshot of gender and grade-based differences in participants' computer attitudes and computer activities. Though past research (e.g., Schumacher & Morahan-Martin, 2001; Shashaani, 1994; Woodrow, 1994) has examined gender and grade differences in computer use, the literature does not include any information on several of the specific computer activities or attitudes included in the current study, nor does the literature describe whether gender differences in computer activities and attitudes may be more likely to exist among adolescents' of different age groups. This section is included to illustrate some interesting gender and grade-based differences that exist in the current sample.

School-Based Differences (9th Grade only)

Prior to examination of gender and grade-based differences in computer activities and attitudes, possible *school-based* differences were assessed with a series of one-way Multivariate Analyses of Variance (MANOVA's), using school as the independent variable. These school comparisons were limited to 9th grade students only, because the sample from HS 2 consisted only of 9th grade students. Before describing school-based differences in activities and attitudes, it is important to note that students in HS 1 (M = 2.89, SD = 1.61) reported having significantly more computers at home than students from HS 2 (M = 2.11, SD = 1.27), $t(259) = 4.16$, $p = .000$, $d = .21$.

Computer Activity-Involvement

A series of four one-way MANOVA's was used to examine school-based differences in participants' computer activities. Means, standard deviations, omnibus F-values, and effect sizes are provided in Table 10. Overall, the omnibus F-tests indicated no significant differences between students from HS 1 and students from HS 2 with regard to miscellaneous computer tasks, computer games, or Internet use. Students from HS 2, however, reported taking more computer courses and spent significantly more time on classroom assignments than students from HS 1.

Computer Attitudes

A series of one-way MANOVA's was used to examine school-based differences in participants' computer attitudes. No significant differences were found.

Gender Differences (Full Sample)

Next, a series of one-way MANOVA's was used to assess *gender differences* among the *full sample* of participants, with regard to computer activities and computer attitudes. Due to a sampling issue that did not allow for grade-based comparisons on the full sample (e.g., HS 2 consisted of only 9th grade students), this series of MANOVA's was used to assess gender differences among the *full sample* of participants in order to maximize power and utilize the entire sample. Following these one-way MANOVA's, a series of two-way MANOVA's were then used on data from HS 1 to examine the relation between adolescents' sex, grade in school, and the interaction of adolescents' sex and grade on computer activity-involvement, computer attitudes, and computer career beliefs.

Computer Activity-Involvement

A series of four one-way MANOVA's was used to examine gender differences in participants' computer activities (e.g., miscellaneous computer tasks, school computer tasks, games, Internet). Means, standard deviations, omnibus *F*-values, and effect sizes are provided in Table 11. Even though no significant gender differences were found with regard to overall time spent on the computer at home, the omnibus *F*-tests indicated significant gender differences for each of the four categories of activities. First, with regard to miscellaneous computer tasks, girls reported spending significantly more time than boys on word processing and educational activities. Boys spent more time than girls on computer programming, taking apart computers, and on computer activities with friends. With respect to in-school computer activities, boys spent significantly more time on classroom assignments, online school activities, and took more computer courses than girls.

Overall, boys spent more time on computer games than girls. Specifically, as expected, boys reported spending significantly more time on action adventure games, sports games, non-computer video games, and on-line games than girls, although there were no significant gender differences for computer puzzle games, simulation games, and classic arcade games. Finally, there were no significant gender differences on overall time spent on the internet or for most internet activities. Means, standard deviations, omnibus *F*-values, and effect sizes are provided in Table 11.

Computer-Related Attitudes

A series of one-way MANOVA's was also used to examine gender differences in participants' computer attitudes, among the full sample. Means, standard deviations, omnibus *F*-values, and effect sizes are provided in Table 12. The omnibus *F*-tests indicated significant gender differences for each of the four categories of attitudes. Specifically, boys reported significantly higher levels of computer anxiety[1] and gender-stereotyped beliefs than girls. However, contrary to past findings, there were no significant gender differences on several measures that have been used in past research, including computer value, computer interest, computer enjoyment, computer self-confidence, and computer outcome expectancy.

1. This was an unexpected finding. Further analyses suggested that there was a small group of about 20 boys who indicated relatively high levels of anxiety, increasing the overall mean for boys. A similar group of girls did not exist.

As mentioned previously, two new measures (Computer Expertise and Computer Value) were created for the current study, each with multiple subscales. Among these new measures, boys reported significantly higher levels of troubleshooting, giving computer help, and computer affect than girls. Girls were more likely than boys to report needing help and seeing the computer as a means for communication. There were no significant gender differences with regard to changing computer preferences or seeing the computer as a tool. Means, standard deviations, omnibus *F*-values, and effect sizes are provided in Table 12.

Computer Career Beliefs

Next, one-way MANOVA's were used to examine gender differences in participants' attitudes about computer careers. Means, standard deviations, omnibus *F*-values, and effect sizes are provided in Table 13. In general, boys reported significantly higher levels of interest, likelihood, and efficacy for computer-related careers than girls. However, these gender differences varied slightly depending on the specific career within the IT domain. Boys reported significantly higher levels of interest, likelihood, and efficacy than girls for computer science, systems analyst, and database administrator jobs. Boys also reported higher efficacy for webmaster, computer support services, and computer teacher careers. There were no significant differences with regard to interest or likelihood of entering webmaster, web development, computer support services, or computer teaching jobs.

Gender-by-Grade Differences (HS 1 only)

Next, a series of 2-way MANOVA's was used to examine the relation between adolescents' sex, grade in school, and the interaction of adolescents' sex and grade on computer activity-involvement, computer attitudes, and computer career beliefs. These gender-by-grade comparisons were made only within HS 1, because as indicated above, HS 2 consisted only of 9th

graders, making it impossible to include HS 2 in analyses examining the effect of grade level. In addition to measuring group differences between boys' and girls' reports, and 9th and 12th graders' reports, these analyses assessed whether gender differences in computer attitudes and activities were more likely to exist among 9th or 12th graders, or if gender differences were stable across the two grade levels.

Computer Activity-Involvement

Means and standard deviations are provided in Table 14. Statistics for significant main effects and interactions will be provided in the text. There were three significant sex-by-grade interactions. First, the interaction of adolescents' sex and grade was a significant predictor of overall time spent on the computer at home, $F(1, 374) = 3.74$, $p = .05$, $\eta^2 = .01$, such that 12th grade boys reported spending more time than 12th grade girls, though 9th grade girls reported spending more time than 9th grade boys (see figure 4). Similarly, the interaction of adolescents' sex and grade was a significant predictor of time spent in chatrooms/instant messaging, $F(1, 374) = 6.02$, $p = .02$, $\eta^2 = .02$, such that 12th grade boys reported spending more time chatting than 12th grade girls, whereas 9th grade girls reported spending more time chatting than 9th grade boys (see figure 5). Finally, the interaction of adolescents' sex and grade was a significant predictor of number of computer courses, $F(1, 374) = 9.17$, $p = .003$, $\eta^2 = .03$, such that the difference between the number of courses taken by 12th grade boys and 12th grade girls was much bigger than the gender difference among 9th graders (see figure 6).

It is also important to point out the computer activity variables that differed by grade level. Compared to 9th graders, students in 12th grade reported spending significantly more time on word processing, $F(1, 374) = 4.75$, $p = .03$, $\eta^2 = .02$, on-line activities at school, $F(1, 374) = 6.39$, $p = .01$, $\eta^2 = .02$, and had taken more computer courses, $F(1, 374) = 22.02$, $p = .00$, $\eta^2 =$

.06. Nevertheless, 9th graders reported spending significantly more time on classroom assignments, $F(1, 374) = 6.71$, $p = .01$, $\eta^2 = .02$, and library research on the computer, $F(1, 374) = 20.11$, $p = .00$, $\eta^2 = .06$, than 12th grade students.

Computer Attitudes

Means and standard deviations are provided in Table 15. Statistics for significant main effects and interactions will be provided in the text. With regard to general computer attitudes, there were two significant sex-by-grade interactions. The interaction of sex and grade was a significant predictor of computer self-confidence, $F(1, 351) = 5.42$, $p = .02$, $\eta^2 = .02$, and computer enjoyment $F(1, 351) = 5.85$, $p = .02$, $\eta^2 = .02$, such that 12th grade boys reported more confidence and enjoyment than 12th grade girls, though the trends were reversed for 9th graders (see figures 7 and 8).

Several sex-by-grade interactions were also detected with regard to the subscales of the Computer Expertise and Computer Values measures. For instance, the sex-by-grade interaction was a significant predictor of Computer Preferences, $F(1, 374) = 5.14$, $p = .02$, $\eta^2 = .01$, and Computers for Communication, $F(1, 374) = 9.34$, $p = .02$, $\eta^2 = .03$; 12th grade boys were more likely to change preferences and see computers as sources of communication than 12th grade girls, though the trend was reversed at grade 9 (see figures 9 and 10).

The sex-by-grade interaction was also a significant predictor of Giving Help, $F(1, 374) = 6.08$, $p = .01$, $\eta^2 = .02$; although 12th grade boys were significantly more likely to report giving help than 12th grade girls, there were no gender differences among 9th graders (see figure 11). Finally, the sex-by-grade interaction was a significant predictor of Needing Help, $F(1, 374) = 4.56$, $p = .03$, $\eta^2 = .01$; though both 9th and 12th grade girls were more likely to report needing help than boys, this difference was larger among 12th graders (see figure 12).

It is also important to point out the computer attitude variables that differed by grade in school. Students in the 9th grade reported significantly higher levels of computer anxiety $F(1, 351) = 5.49$, $p = .02$, $\eta^2 = .02$, and less traditional gender stereotypes, $F(1, 374) = 3.86$, $p = .05$, $\eta^2 = .01$, than 12th graders.

Computer-related Career Beliefs

Means and standard deviations are provided in Table 16. Although there were several gender-based differences in computer career beliefs among the full sample (described above), there were no significant grade-based differences in computer career beliefs. There was one significant sex-by-grade interaction, $F(1, 374) = 10.26$, $p = .001$, $\eta^2 = .03$; 12th grade boys reported higher levels of efficacy for computer teacher careers than 12th grade girls, whereas 9th grade girls reported higher teaching efficacy than 9th grade boys (see Figure 13).

Research Question 2. Are adolescents' computer activities and attitudes related to their computer-related career beliefs, as would be expected by Eccles et al. (1998) expectancy-value model of achievement motivation? Does adolescents' sex moderate the relation between computer attitudes and computer-related career beliefs?

Research question 2 was examined with four separate hierarchical linear regressions, assessing the relation between adolescents' background characteristics, computer attitudes, computer activities, and computer-related career beliefs. As predicted by Eccles and colleagues' (1983) model, it was expected that adolescents' achievement-related experiences (computer activities), traditional gender stereotypes, general self-schemata (computer self-confidence), expectations for success (outcome expectancies), intrinsic value (computer interest), and utility value (computer value), would be related to achievement-related beliefs (computer career interest and computer career efficacy). This set of predictors has been highlighted in Eccles and colleagues' (1983) comprehensive model (see Figure 2).

Computer Career Interest

A hierarchical linear regression analysis was used to test the relationship between a set of predictors (adolescents' background characteristics, computer attitudes, computer activities) and adolescents' *computer career interest.* Factors were entered into the model in separate steps so that the unique contribution of each group of variables could be examined. Step one of the analysis included background characteristics such as adolescents' sex (coded females = -.5, males = .5), age, school, and number of home computers. As shown in Table 17, Adolescent Sex was a significant predictor of Computer Career Interest, such that boys reported significantly higher levels of Computer Career Interest than girls. The other background characteristics were not related to Computer Career Interest.

The predictor variables in step two of the model were identical to step one, with the addition of computer attitudes, namely Computer Outcome Expectancy, Computer Gender Stereotypes, Computer Value, Computer Self-Confidence, Computer Interest, the interaction of Sex and Computer Value, and the interaction of Sex and Gender Stereotypes (see Table 17). All predictor variables added in step two were grand mean centered for ease of interpretation. Grand mean centering of a variable involves subtracting the mean from each of the scores to create deviation scores. This technique allows for greater ease of interpreting coefficients and reduces collinearity (Aiken & West, 1991; Bryk & Raudenbush, 1991).

The interaction terms were constructed by first standardizing Computer Value and Gender Stereotypes and then multiplying each by adolescent sex. Variables used to form the interaction may not be interpreted simply as main effects, but may be meaningfully interpreted in light of the interaction (see Judd & McClelland, 1989). In each analysis, sex of child was coded as females = -.5, males = .5, so that the coefficient for sex corresponds to the sex difference in standard deviation units at the mean level of Computer Value and Gender Stereotypes. Because of this coding strategy, the coefficients for Computer Value and Gender Stereotypes may be interpreted as being averaged across males and females. The coefficient for the interaction term corresponds to variation in the sex difference across levels of Computer Value and Gender Stereotypes. A positive coefficient indicates that as Computer Values or reports of traditional Gender Stereotypes grow stronger, the sex difference increases in the direction of higher scores for males. The magnitude of the coefficient reflects the amount of change in the sex difference per standard deviation of stereotyping (Kerlinger & Pedhazur, 1973, pp. 252-253).

As shown in Table 17, after controlling for important background characteristics, Computer Outcome Expectancy, Computer Value, and Computer Interest were each significant predictors of computer career interest. As predicted, Computer Outcome Expectancy and Computer Interest were both positively related to Computer Career Interest; however, contrary to expectations, Computer Value was negatively related to Computer Career Interest. Gender Stereotypes, Computer Self-confidence, and the two interaction terms were not significant predictors of Computer Career Interest.

The predictor variables in step three of the model were identical to step two, with the addition of computer activities, namely Time Spent on Games, Time Spent on Programming, and Time Spent with Friends on Computers. Each predictor was grand mean centered for ease of interpretation. Time Spent on Programming and Time Spent with Friends on Computers were both positively related to Computer Career Interest, though Time Spent on Games was not related. The significant relationships described in step 2 remained intact, though Adolescents’

Sex was not a significant predictor of Computer Career Interest in the final model. The R^2 for the final model was .25, indicating that the predictor variables explained 25% of the variance in adolescents' reports of Computer Career Interest.

In order to incorporate some of the new measures that were created in the current study and provide improved models of explanation for computer career interest, a second hierarchical linear regression model was used to measure the relationship between additional attitudinal measures (e.g., troubleshooting, computer affect, computer career/family compatibility), additional activity measures (courses), and Computer Career Interest. Factors were entered into the model in separate steps so that the unique contribution of groups of variables could be examined. As before, step one of the analysis included background characteristics such as Adolescents' Sex (coded females = -.5, males = .5), Age, School, and Number of Home Computers. As shown in Table 18, Adolescent Sex was a significant predictor of Computer Career Interest, such that boys reported significantly higher levels of interest than girls. The other background characteristics were not related to Computer Career Interest.

The predictor variables in step two of the model were identical to step one, with the addition of computer attitudes, namely Computer Affect, Troubleshooting, Computer Career and Family Compatibility, and the interaction of Sex and Computer Career and Family Compatibility (see Table 18). It was hypothesized that computer affect and the ability to troubleshoot computer problems would be positively associated with computer career interest. In addition, it was hypothesized that the interaction of sex and feelings about the compatibility of a computer career and family demands would be a significant predictor of computer career interest, such that high levels of compatibility would be more associated with career interest for girls than for boys.

All predictor variables added in step two were grand mean centered for ease of interpretation, and the interaction terms were created in the same manner described above. As shown in Table 18, after controlling for important background characteristics, Liking Computers and Troubleshooting were positively and significantly related to career interest. The main effect of Computer Career and Family Compatibility was a moderately significant predictor of Computer Career Interest ($p = .06$), whereas the interaction of Adolescent Sex and Computer Career and Family Compatibility was a significant predictor of Computer Career Interest. As displayed in Figure 14, the significant interaction finding surprisingly suggests that perceiving high levels of compatibility between computer careers and family obligations is more strongly related to positive levels of Computer Career Interest for boys than for girls.

The predictor variables in step three of the model were identical to step two, with the addition of computer activities, specifically Time Spent on Computer Games, Number of Computer Courses, and Time Spent on Programming. It was predicted that time spent on each of these activities would be positively associated with Computer Career Interest. Each predictor was grand mean centered for ease of interpretation. The Number of Computer Courses and Time Spent on Programming were both significant predictors of Computer Career Interest, though Time Spent on Games was not a significant predictor. Most of the significant relationships described in steps 1 and 2 remained intact, though Adolescent Sex and the interaction of Adolescent Sex and Computer Career and Family Compatibility were no longer significant predictors in the full model. However, in the full model, the main effect of Computer Career and Family Compatibility became a statistically significant predictor of Computer Career Interest. This finding suggests that both male and female adolescents are more likely to report higher levels of Computer Career Interest when they perceive high levels of compatibility between computer careers and family obligations. The R^2 for the final model was .26, indicating that the predictor variables explained 26% of the variance in adolescents' reports of Computer Career Interest.

Computer Career Efficacy

A hierarchical linear regression analysis was also used to test the relationship between this set of predictors (adolescents' background characteristics, computer attitudes, computer activities) and adolescents' *computer career efficacy*. Factors were entered into the model in separate steps so that the unique contribution of groups of variables could be examined. Step one of the analysis included background characteristics such as Adolescents' Sex (coded females = -.5, males = .5), Age, School, and Number of Home Computers. As shown in Table 19, Adolescent Sex was a significant predictor of Computer Career Efficacy, such that boys reported significantly higher levels of efficacy than girls; additionally, the Number of Computers students had in their homes was also significantly and positively related to Computer Career Efficacy.

The predictor variables in step two of the model were identical to step one, with the addition of computer attitudes, namely Computer Outcome Expectancy, Gender Stereotypes, Computer Value, Computer Self-Confidence, Computer Interest, the interaction of Sex and Computer Value, and the interaction of Sex and Gender Stereotypes (see Table 19). All predictor variables added in step two were grand mean centered for ease of interpretation, and the interaction terms were created in the same manner described above. As shown in Table 19, after controlling for important background characteristics, Computer Outcome Expectancy, Computer Value, Computer Self-Confidence, Computer Interest, and the interaction of Sex and Gender Stereotypes were each significant predictors of Computer Career Efficacy. As expected, Computer Outcome Expectancy, Computer Self-Confidence, and Computer Interest were positively related to career efficacy; however, Computer Value had an unexpected negative relation with Computer Career Efficacy. The interaction of Sex and Gender Stereotypes was a significant predictor of Computer Career Efficacy, such that boys' reports of Gender Stereotypes were positively related to efficacy, whereas the relation was in the negative direction for girls (see Figure 15).

The predictor variables in step three of the model were identical to step two, with the addition of computer activities, specifically Time Spent on Computer Games, Programming, and Computer Activities with Friends. Each predictor was grand mean centered for ease of interpretation. Most of the significant relationships described in steps 1 and 2 remained intact, though Adolescent Sex and Number of Home Computers were no longer significant predictors when activity variables were added to the model. In the final model, Time Spent on Programming and Time Spent with Friends on Computers were positively related to Computer Career Efficacy, though Time Spent on Games was not a significant predictor. The R^2 for the final model was .30, indicating that the predictor variables explained 30% of the variance in adolescents' reports of Computer Career Efficacy.

Finally, in order to incorporate some of the new measures that were created in the current study and provide improved models of explanation for Computer Career Efficacy, a separate hierarchical linear regression model was used to measure the relationship between additional attitudinal measures (e.g., troubleshooting), additional activity measures (courses, time spent helping others with computer tasks), and computer career efficacy. Factors were entered into the model in separate steps so that the unique contribution of groups of variables could be examined. Step one of the analysis included background characteristics such as Adolescents' Sex (coded females = -.5, males = .5), Age, School, and Number of Home Computers. As shown in Table 20, Adolescent Sex was a significant predictor of Computer Career Efficacy, such that boys reported significantly higher levels of efficacy than girls; additionally, the number of computers students had in their homes was also significantly and positively related to Computer Career Efficacy.

The predictor variables in step two of the model were identical to step one, with the addition of computer attitudes, namely Computer Self-Confidence, Troubleshooting, Gender Stereotypes, and the interaction of Sex and Gender Stereotypes (see Table 20). It was hypothesized that computer self-confidence and the ability to troubleshoot computer problems would be positively associated with computer career efficacy. In addition, it was hypothesized that the interaction of sex and traditional gender stereotypes would be a significant predictor of computer career efficacy, such that boys' reports of gender stereotypes would be positively related to efficacy, whereas the relation would be in the negative direction for girls.

All predictor variables added in step two were grand mean centered for ease of interpretation, and the interaction terms were created in the same manner described above. As shown in Table 20, after controlling for important background characteristics, Self-Confidence, Troubleshooting, and the interaction of Sex and Gender Stereotypes were each significant predictors of Computer Career Efficacy. As expected, Self-Confidence and Troubleshooting were positively related Computer Career Efficacy. The interaction of Sex and Gender Stereotypes was a significant predictor of Computer Career Efficacy, such that boys' reports of Gender Stereotypes were positively related to efficacy, whereas the relation was in the negative direction for girls.

The predictor variables in step three of the model were identical to step two, with the addition of computer activities, specifically Number of Computer Courses, Time Spent Programming, and Time Spent Helping Others with Computer Tasks. Each predictor was grand mean centered for ease of interpretation. Most of the significant relationships described in steps 1 and 2 remained intact, though Adolescent Sex and Number of Home Computers were no longer significant predictors when activity variables were added to the model; however, Adolescent Age became a significant predictor of Computer Career Efficacy in the final model, with younger adolescents reporting more career efficacy than older students. In addition, in the third step, Number of Courses and Time Spent Helping Friends with Computer Tasks were both significantly and positively related to Computer Career Efficacy. The R^2 for the final model was .32, indicating that the predictor variables explained 32% of the variance in adolescents' reports of Computer Career Efficacy.

Research Question 3. Are there individual differences in adolescents' computer activities? Can distinct groups or clusters of adolescents be identified, and will they vary by adolescents' sex and grade?

SPSS cluster analysis (*k* means cluster command) was used to determine patterns of computer activity involvement among adolescents. The cluster analysis included the total number of computer courses as well as time spent on the following computer activities: games, Internet, creative activities (photo/music/drawing/art), computer programming, taking apart/fixing computers, helping friends/family with computers, computer activities with friends, and word processing. SPSS clustering procedures identify homogeneous groups of cases by assigning all participants to clusters based on the Euclidean distance (see Milligan, 1996) from group centers. Table 21 presents the means and standard deviations of the nine variables for each of the clusters. The empirical clusters included the following:

Cluster 1, The Techno-Gamers: Adolescents in this cluster reported relatively high levels of game playing, computer programming, taking apart and fixing of computers, and computer activities with friends, and also reported higher numbers of computer courses than adolescents in other clusters. These adolescents reported relatively average values on all other variables (creative activities, Internet use, and word processing).

Cluster 2, The Web Surfers: Adolescents in this cluster reported relatively high levels of creative activities (photo/music/drawing/art), high Internet use, high levels of computer activities with friends, and high levels of word processing; however, they reported relatively low levels of time spent on computer games, programming, and taking apart/fixing computers.

Cluster 3, The Moderates: This group was composed of the largest number of participants. Compared to other adolescents, adolescents in this cluster had average or below average reports of time spent on each type of computer activity.

The replicability of the three-cluster solution was tested by drawing 3 random 50% sub-samples from the data set, as done in previous research (see Weems, Hayward, Killen, & Taylor, 2002). The same clusters were evident across sub-samples. The Analysis of Variance (ANOVA) shown in Table 22 suggests that time spent on games and Internet activities carried the greatest weight in distinguishing among the clusters. This table should be used only for descriptive purposes; the clusters were chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

After clusters were formed and replicated, chi-square analyses were used to investigate gender and grade-level differences in cluster membership. Although clusters did not differ significantly by grade in school, $\chi^2(6, n = 382) = 3.67, p = .72$, a chi-square analysis did show differences in cluster membership based on adolescents' sex, $\chi^2(2, n = 382) = 48.37, p < .001$.

Cluster 1 (Techno-Gamers) was primarily composed of male adolescents (83% males, 17% females), whereas female adolescents were more highly concentrated in Cluster 2 (Web Surfers; 66% females, 34% males). In comparison, the proportions of male and female adolescents in Cluster 3 (The Moderates) were more equivalent (43% males, 57% females).

A one-way ANOVA was also used to determine whether the clusters varied by number of home computers. Results suggest that adolescents in clusters did vary by number of home computers, $F(2, 382) = 4.97$, $p = .01$. LSD post-hoc analyses suggested that adolescents in cluster 1 ($M = 3.10$, $SD = 1.69$) and cluster 2 ($M = 2.97$, $SD = 1.49$) had significantly more home computers than adolescents in cluster 3 ($M = 2.56$, $SD = 1.39$), $F(2, 382) = 4.97$, $p = .01$.

Research Question 4. If distinct patterns or groups are identified, do particular patterns of computer activities relate to adolescents' career goals? Does adolescents' sex moderate this relationship?

A 2-way ANOVA was performed using Adolescent Sex and Cluster Membership as the between-subjects factors and Computer Career Interest as the dependent variable. Number of home computers was included as a covariate in this analysis. Results of the overall test indicated significance of the model, $F\ (6, 379) = 2.95$, $p < .01$, see Table 23. Although the main effect of sex was not a significant predictor, cluster membership did predict Computer Career Interest, $F\ (2, 379) = 3.80$, $p < .02$. LSD post-hoc analyses suggested that Techno-Gamers had significantly higher levels of computer career interest ($M = 2.57$, $SD = 1.30$) than The Moderates ($M = 2.11$, $SD = 1.08$). The interaction of cluster and adolescents' sex was not a significant predictor of Computer Career Interest.

An additional 2-way ANOVA was performed using Adolescent Sex and Cluster Membership as the between-subjects factors and Computer Career Efficacy as the dependent variable. Once again, number of home computers was included as a covariate in this analysis. Results of the overall test indicated significance of the model, F (6, 379) = 5.46, $p < .001$, see Table 24. The main effect of sex was a significant predictor of Computer Career Efficacy, F (1, 379) = 5.31, $p < .05$, such that boys reported higher levels of efficacy than girls. The main effect of cluster membership was also a significant predictor of computer career efficacy, F (2, 379) = 5.67, $p < .001$. LSD post-hoc analyses suggested that The Moderates (*M* = 2.75, *SD* = 1.50) had significantly lower levels of Computer Career Efficacy than The Techno-Gamers (*M* = 3.57, *SD* = 1.49) or The Web Surfers (*M* = 3.17, *SD* = 1.31). The interaction of cluster and adolescents' sex was not a significant predictor of computer career efficacy.

Discussion

The current study answered four research questions, all of which have the potential to significantly contribute to the literature on gender differences in the domain of computers. Guided by Eccles and colleagues' (1998) expectancy-value model of achievement motivation, analyses were conducted to uncover possible explanations for the gender gap within the broad field of computer and technology-oriented careers, by measuring adolescents' expectations for success, values, and activity-involvement. In addition to overcoming some measurement issues found in past research, the current study contributes to existing knowledge by: (1) providing an updated picture of gender and grade-based differences in adolescents' computer activities, attitudes, and computer-related career beliefs; (2) illustrating the possible predictive relation between adolescents' sex, age, attitudes, activities, and career beliefs; (3) examining patterns of individual differences in computer use and activities; and (4) illustrating the possible predictive relation between patterns of computer use, adolescents' sex, and career beliefs.

Before describing and interpreting the results of the analyses, it is important to point out that the current study improved upon several measurement limitations found in past research. First, the current study included items about multiple careers within the technology workforce, rather than simply asking about computer science. Additionally, in order to more accurately capture the breadth of adolescents' current computer attitudes, two new attitudinal measures were developed. And finally, the current study included a wide range of activity-related questions, delineated between several distinct groups of computer-users, and provided some insight into how these patterns of computer activities might be related to career beliefs.

In addition to these measurement improvements, the findings of the current study begin to provide some explanation for the existing gender gap in the technology workforce. According to Eccles and colleagues' (1983; 1998) model, achievement-related choices, such as computer career beliefs, are guided by three major factors: activities, expectations for success, and value for the domain. Current results provide evidence consistent with Eccles and colleagues' (1998) theorized associations between these factors, with gender moderating some of the relationships. Overall, adolescents' self-confidence, reports of troubleshooting, computer time with friends, gender beliefs, and enrollment in computer courses were related to computer career beliefs. Discussion of the specific findings and interpretations are described below.

Activity Involvement

Consistent with most research (e.g., Sax et al., 2000), the current study found no significant gender differences in overall time spent on the computer. On average, both male and female adolescents reported spending a little over two hours a day on computer and Internet activities at home. Importantly, although overall time spent on the computer did not differ by sex, the interaction of adolescents' sex and grade in school was a significant predictor of overall time spent on the computer at home; 12th grade boys reported spending significantly more time than 12th grade girls, though the gender difference was very small during 9th grade, with girls reporting slightly more time than boys. This pattern of findings, showing gender differences favoring boys in the 12th grade was found on several activity and attitudinal variables, and is consistent with past research suggesting that the gender gap in computer involvement widens to favor boys as students move through high school (Mayfield, 2001; Sax et al., 2000; Wright et al., 2001). Unfortunately for girls, this gender gap in computer activities and attitudes may be widening at the same time that adolescents are beginning to make important career-related decisions.

As expected, several interesting gender differences were uncovered with respect to time spent on *specific* computer and Internet activities. Consistent with past research (e.g., Cole, 2000), girls in the current study reported spending significantly more time than boys on academic activities such as word processing and Internet research for school, regardless of grade in school. Boys, however, spent more time than girls on computer programming, computer activities with friends, and classroom assignments on the computer. Past research has suggested that activities such as computer programming and computer coursework are predictors of positive attitudes towards computers and technology, and may help adolescents become interested in obtaining computer-related careers (Schumacher & Morahan-Martin, 2001).

Boys also spent more time than girls on computer games, though gender differences with regard to computer games were dependent on the type of game. Boys reported spending significantly more time on action adventure games, sports games, non-computer video games, and on-line games than girls, whereas no gender differences were found for computer puzzles, simulation games, and classic arcade games. Although past research has generally suggested that females spend less time than males playing computer and video games (e.g. Mayfield, 2001; Sax at al., 2000; Wright et al., 2001), the current study moves beyond these general findings by showing which types of games generate the largest gender differences. The computer industry has made strides in the past several years, creating and marketing more games to female players, moving beyond "girl" games of the past, such as Barbie© fashion software, which focused on physical appearance and fashion (Beatto, 1997; Maisel, 1997). Many of the new games that are attractive to female players fall in the categories of simulation games (e.g., The Sims) and classic arcade games (e.g., Ms. Pacman), and are challenging and entertaining for both girls and boys (Children Now, 2000; Loftus, 2004). It appears as though adolescent girls in the current sample have picked up on these trends and report spending as much time playing these games as their male counterparts. Though it is perhaps too early to tell whether girls' increased involvement with games will be translated into career decisions, the current findings do provide interesting information about which types of games are most attractive to adolescent girls.

Computer Attitudes: Expectations for Success and Value

Overall, it was expected that boys would report more positive computer-related attitudes than girls. It was also expected that gender differences in value and computer outcome expectancy would be greater among 12th graders than 9th graders. Contrary to predictions based on past findings (e.g., Kadijevich, 2000; Levin & Barry, 1997; Liao, 1999; Mayfield, 2001; Shashaani, 1994; Shashaani, 1995; Whitley, 1997), there were no significant gender differences in the current study on several attitudinal measures that have been used in past research, including computer value, computer interest, computer enjoyment, and computer outcome expectancy. Perhaps the current study did not find gender differences on these measures because contrary to past research, the boys and girls in the current sample reported spending about the same amount of time on computer activities each day, helping to decrease the gender gap in attitudes that has been found in past studies. The interaction of adolescents' sex and grade was a significant predictor of computer self-confidence, however, such that 12^{th} grade boys reported more confidence than 12^{th} grade girls, though 9^{th} grade girls reported more confidence than 9^{th} grade boys.

Boys also reported significantly higher levels of computer anxiety and more traditional gender-stereotyped beliefs than girls. Although the gender differences in gender-stereotyped beliefs are consistent with past research (see Dryburgh, 2000), it is very intriguing that males reported *higher* levels of computer anxiety than their female counterparts, especially given that adolescent males in the current sample were also more likely to help others with computers, troubleshoot computer problems, and reported higher computer self-confidence at grade 12. Moreover, past research has routinely uncovered a gender gap in computer anxiety, characterized by significantly higher levels of anxiety among females (Todman, 2000).

Perhaps now that most adolescents have daily contact with computers, the computer anxiety measure used in the current study may not actually measure computer anxiety as it did in the past. Although the computer anxiety scale (Selwyn, 1997) was originally created to assess individuals' anxiousness with regard to touching or using computers, it seems that in the current study the measure actually assessed the degree to which adolescents' cared about whether they looked and felt capable around computers. Male adolescents may have been more likely than females to score highly on this measure because they are expected by peers, teachers, and parents to make fewer mistakes when using computers than girls, and thus feel more "anxiety" with regard to computers.

Male adolescents in the current study also reported significantly higher levels of troubleshooting, giving computer help, and computer affect than female adolescents. Importantly, the gender difference with regard to giving help was contingent on grade level; although 12th grade boys were significantly more likely to report giving help than 12th grade girls, there was no gender difference among 9th graders. Moreover, even though 12th grade boys were more likely to change computer preferences than 12th grade girls, the gender pattern was reversed among 9th grade students. These gender-by-grade findings are consistent with past research that has reported a larger gender gap in computer attitudes as adolescents near the end of high school, with males revealing more positive attitudes toward technology (Kirkpatrick & Cuban, 2000). It is important to point out, however, that due to the cross-sectional nature of the data, it is possible that these grade-based differences are cohort-based, rather than representing some developmental phenomenon. Perhaps the absence of large gender differences among 9th grade adolescents in the current study will remain as these students progress through high school at the same time that educational systems become increasingly inundated with computers and as society becomes less gender-typed with regard to computers.

Finally, regardless of gender, students in the 12th grade reported more traditional gender stereotypes with regard to computer ability than 9th grade students. Once again, because of the cross-sectional nature of the data, it is difficult to know whether these grade-based differences in gender stereotypes are based on a developmental or cohort-based phenomenon. It is possible that 9th grade adolescents, who entered the school system three years after the 12th grade adolescents, were exposed to more equality with regard to computers and technology throughout their lifetimes, thus resulting in lower reports of computer gender stereotypes. It is also possible that gender stereotypes increase as adolescents' near the end of high school. According to the gender intensification hypothesis, for instance, sex-typed socialization may become most evident as adolescents are anticipating future adult roles (Hill & Lynch, 1983). Moreover, past research has suggested that computer gender stereotypes increase with computer experience (see Dryburgh, 2000). Students in the 12th grade likely had more computer experience than 9th graders as well as more opportunities to notice that male students enroll in computer courses at higher rates than female students, possibly increasing their gender-typed beliefs.

Even though girls and boys have similar levels of interest and enjoyment, their differing levels of self-confidence, troubleshooting, needing help, and giving help may be related to later gender differences in computer-related career choices, which would be consistent with the findings of researchers such as Eccles et al. (1998) and Bandura et al. (2001). These findings help illustrate important gender differences that researchers and teachers could consider when developing programs and interventions aimed at encouraging girls and women to attain computer-related careers. Increasing girls' feelings of self-confidence and giving them the skills to help others with computers may be more important for closing the gender gap in the computer workforce than simply encouraging girls to use the computer.

Computer Career Beliefs

Regardless of gender or grade, interest in the computer-focused jobs included in the current study was very low. On a seven-point scale with larger values indicating more interest, the average level of interest for these careers ranged from 1.65 (database administrator) to 3.10 (computer scientist). Clearly, the majority of adolescents in the current study were not particularly interested in obtaining careers in the technology workforce. It is possible that adolescents would have indicated higher levels of interest if the computer careers were presented in the context of specific areas of work, such as health care, education, or business. Nevertheless, despite their low levels of interest, the adolescents (particularly male participants) did indicate moderate levels of efficacy for these careers. Thus, even though students were not necessarily interested in entering careers in technology, they did report a certain level of efficacy for working in these types of careers.

As expected, boys generally reported significantly higher levels of interest, likelihood, and efficacy for computer-related careers than girls. These gender differences, however, varied depending on the specific career within the computer/technology domain. Boys reported significantly higher levels of *interest* than girls for computer science, systems analyst, and database administrator jobs, though there were no significant differences with regard to interest in webmaster, web development, computer support services, or computer teaching jobs.

Based on the literature suggesting that females are most interested in computers when they can see the relations between computer technology and applied and/or social contexts (Gilbert, 2002; Stabiner, 2003), it was expected that girls would be more likely to indicate interest in pursuing the more “people and society-oriented” computer jobs, such as computer support services, web design, and teaching. Although these exact trends were not found in the current study, it does appear as though gender differences were smaller and non-significant with respect to web design, computer support, and computer teaching. Out of all the careers listed on the survey, girls were most interested in web development, and reported slightly higher interest for computer teaching careers than boys. Thus, it seems possible that females may become more involved in the technology workforce within the next several years, as these “people and society-oriented” types of occupations become more visible and open to young women.

Boys reported higher *efficacy* than girls for all of the careers, with the sole exception of web development. Although this finding is not entirely surprising, given recent research suggesting that males have significantly higher levels of computer efficacy than females, (Kirkpatrick & Cuban, 2000; Sax et al., 2000), it is striking that such uniform gender differences were found with respect to computer career efficacy, despite the fact that boys and girls in the current study reported similar amounts of time spent on computer activities.

Summary

Overall, the current study suggests that adolescent males and females generally spend about the same amount of time on computer *activities* each day and report similar computer *attitudes*, in terms of computer interest, enjoyment, and outcome expectancy. Some striking gender differences, however, were found with respect to measures of self-confidence, certain computer activities, and on reports of computer *career beliefs*, and many of these gender differences were larger among 12th graders than 9th graders. Compared to 12th grade girls, boys in the 12th grade reported spending more time on computer activities, took more computer courses, reported higher levels of self-confidence, and were more likely to give computer help to others. These gender differences did not exist among 9th graders, and in some cases, 9th grade girls actually reported more positive computer beliefs than their male counterparts. These gender-by-grade effects are consistent with past findings indicating a larger gender gap in computer attitudes as adolescents near the end of high school, with males revealing more positive attitudes toward technology (Kirkpatrick & Cuban, 2000). The findings highlight the importance of encouraging 9th grade female students to enroll in computer courses and consider future careers in the IT workforce while their computer beliefs are still generally positive, and in some cases, more positive than their male counterparts.

Relations between Attitudes, Activities, and Career Beliefs

Although the simple differences between boys' and girls' computer attitudes, activities, and career beliefs described above may be interesting in and of themselves, they offer no explanation as to why gender differences exist, nor do they provide any useful information about the possible relations between computer attitudes, activities, and career beliefs. Thus, regression analyses were used to examine the relationships between attitudinal and activity variables and career interest and efficacy, while controlling for important background characteristics such as adolescents' sex, age, school, and number of home computers. These background characteristics were included in analyses so that the direct relationship between career beliefs and computer attitudes and activities could be assessed, while holding computer ownership and demographic characteristics constant.

Two analyses were used to investigate predictors of computer career interest. As predicted by the Eccles expectancy-value model (Eccles et al., 1983), computer outcome expectancy, computer interest, computer affect, and troubleshooting were all positively related to computer career interest; thus adolescents who believe that computers have utility value, those who have fun using computers, and those who enjoy figuring out computer problems are most interested in computer careers. Although these findings are consistent with past research (Kiesler, Zdaniuk, Lundmark, & Kraut, 2000) which has suggested that teenagers who give more technical help to family members also tend to have higher interests and abilities with computers, the relationship between troubleshooting and computer *career interest* is a new addition to research in this area.

Contrary to expectations, however, there was a negative relationship between computer career interest and computer value, as measured by the CASCQ value subscale, developed by

Levine and Donitsa-Schmidt (1997). As argued earlier, on face value, this computer value scale seems outdated; each adolescent who took the web-based survey knows how to use computers, and most participants reported using computers on a daily basis; thus it is possible that items like "everyone should know how to use a computer" may not be very relevant for this group of students. However, it is still surprising that this variable is *negatively* related to computer career interest. Perhaps students who are most interested in computer careers do not see the importance of computers in *other* people's lives, but instead believe that only those who work in the computer industry should be educated about computers. It is important to point out that this significant, negative relationship did not appear until controlling for adolescents' sex, age, and other computer attitudes; thus, the model may illustrate a suppression effect (Tzelgov & Henik, 1991).[2] Still, this is an unexpected finding and warrants further investigation.

Both the main effect and the interaction of Computer Career/Family Compatibility and sex were significant predictors of computer career interest. Although both male and female adolescents were more likely to report higher levels of career interest when they perceived high levels of compatibility between computer careers and family obligations, high levels of compatibility were more strongly related to positive levels of career interest for boys than for girls. This finding is surprising, given past research that suggests that compatibility between work and family obligations is traditionally more important for females than for males. According to Stickel and Bonett (1991), women may fail to pursue nontraditional careers, such as those in technology, because they doubt their ability to combine work requirements with home/family responsibilities. The current findings provide optimistic evidence that male adolescents may also think about the connections between work and family, and may base career interests on the perceived compatibility between the two roles.

2. A simple correlation analysis shows that the relationship between computer value and computer career interest is almost zero. Thus, this significant, negative relationship only appears after controlling for other variables in a regression model, suggesting a possible suppression effect (Tzelgov & Henik, 1991).

The time adolescents spent on programming and computer activities with friends were also both positively related to interest in computer careers. Past research has often found a strong connection between computer programming and interest in computer careers (Gilbert, 2002; Schumacher & Morahan-Martin, 2001), so this finding is not surprising. The relationship between career interest and spending computer time with friends, however, is a new finding, and negates past research that has suggested that computer careers are only attractive to socially-isolated adolescents (Dryburgh, 2000). Although much past research (e.g., Cassell & Jenkins, 1998; Levine & Donitsa-Schmidt, 1997) has suggested a strong correlation between time spent playing computer games and positive attitudes about computers and careers in technology, this relationship was not found in the current study; most likely this is because computer games have become highly accessible and very popular within the mainstream adolescent population. Computer games are no longer limited to diehard computer users who plan to pursue careers in technology.

Two analyses were also used to investigate predictors of computer career *efficacy*. After controlling for important background characteristics, computer outcome expectancy, computer self-confidence, troubleshooting, and computer interest were positively related to career efficacy. Thus, as predicted by the Eccles expectancy value model (Eccles et al., 1983), adolescents' perceptions of utility value, interest, and expectations for success all predict feelings of efficacy for careers in technology. Levine and Donitsa-Schmidt's (1997) measure of computer value, however, had an unpredicted negative relation with computer career efficacy in the current study. Similar to findings for the negative relation between value and career interest described above, this finding is unexpected and warrants further investigation.

The interaction of sex and gender stereotypes was also a significant predictor of computer career efficacy, such that boys' reports of gender stereotypes were positively related to efficacy, whereas the relation was in the negative direction for girls. This finding is similar to past research showing that girls with traditional gender stereotypes have less positive attitudes about technology (Francis, 1994). Moreover, recent research has shown that men's traditional gender stereotypes are positively associated with self-efficacy for masculine careers such as those in science and technology, though the association between gender stereotyped beliefs and efficacy for masculine careers is negative for women (Chhin, Bleeker, & Jacobs, 2005).

Time spent on programming, time spent with friends on computers, and time spent helping friends and family with computer problems were all positively related to computer career efficacy, though time spent on games was not a significant predictor. Past research has often found a strong connection between computer programming and perceived efficacy for computer careers (Gilbert, 2002; Schumacher & Morahan-Martin, 2001). The relationship between career efficacy and spending computer time with friends and helping friends and family with computer problems are both new findings, and support recent research that has begun to negate the popular stereotype of people who are competent with computers as socially inadequate and socially isolated (Orleans & Laney, 2000; Schott & Selwyn, 2000). Instead, adolescents in the current study who were most efficacious with regard to computer careers were also likely to spend computer time with friends and help others with computer problems.

Overall, the current findings provide evidence for Eccles and colleagues' (1998) theorized associations between activities, expectations for success, and career goals, suggesting that adolescents' levels of self-confidence, troubleshooting, computer time with friends, gender beliefs, and enrollment in computer courses are related to computer career beliefs. Some findings in the current study are inconsistent with previous findings; these inconsistencies may be explained by the use of no longer valid measures (e.g., computer value) or the fact that past research has generally assessed the relations between computer attitudes, activities, and beliefs about careers in computer science, without controlling for age, number of home computers, or examination of interactions with sex. Previous research has also failed to consider the various computer-related career beliefs within the broad domain of technology (i.e., web design, support services, computer teacher) that are included in the current study.

Activity-based Groups of Computer Users

Finally, although past research has examined gender differences in computer activities, research has not attempted to consider individual differences in adolescents, based on their computer activity-involvement. The cluster analysis used in the current study identified three groups of adolescents, providing some initial insight into the ways different groups of adolescents use the computer. Overall, the three groups were most differentiated based on time spent on games and time spent on the Internet. The first cluster, the Techno-Gamers, was composed primarily of male adolescents; members of this group reported relatively high levels of game playing, computer programming, taking apart and fixing of computers, computer activities with friends, and computer courses. Further analyses suggested that these adolescents reported higher levels of computer career interest than adolescents who were only moderate users of the computer.

The second cluster, the Web Surfers, was composed primarily of female adolescents. These adolescents reported very high Internet use, relatively high levels of creative activities (photo/music/drawing/art), and higher than average levels of computer activities with friends and word processing; however, they reported relatively low levels of time spent on computer games, programming, and taking apart/fixing computers. The final cluster, the Moderates, was composed of the largest number of participants. Compared to other adolescents, the Moderates spent average or below average amounts of time on each type of computer activity. Further analyses suggested that adolescents in the Moderates cluster had significantly lower levels of computer career efficacy than Techno-Gamers or Web Surfers.

Although past research has investigated adolescents' computer activities, computer use measures have typically been limited in scope and restricted to activities such as programming, video games, and word-processing. With the increasing ubiquity of computers and the spread of computer use beyond areas of programming and typing, these past notions of computer activities need to be expanded. Understanding the breadth of computer activities is especially important as we try to comprehend the significant gender gap that appears as adolescents finish high school and begin to plan for their future careers. The current analyses provide some insight into the ways different groups of adolescents use the computer, and suggest that these patterns may be associated with efficacy and interest in computer careers. In particular, adolescents who spend time playing games, programming, and fixing computers, as well as adolescents who spend a lot of time on the Internet and on computer activities with friends report higher levels of efficacy for computer careers than adolescents who are moderate or average users of computer technology.

These results provide a novel contribution to the literature by suggesting various patterns of computer use, based on types of activity-involvement that have not been assessed in past research, such as helping friends and family with computer problems. The current results also suggest that these individual differences in activity-involvement may be related to computer career interest and efficacy. Although the patterns of activity-involvement varied by sex, the relationships between the various patterns of activities and career beliefs were not moderated by sex, suggesting that the relationship between adolescents' computer activities and career attitudes is the same for male and female adolescents. These findings move beyond decade-old research suggesting that the computer attitudes of males were more sensitive to activity-involvement than were those of females (Woodrow, 1994). However, this set of analyses was exploratory in nature and definitive conclusions cannot be made without further investigation into these patterns of involvement.

Limitations

Although the current findings have the potential to add to the literature on adolescents' computer activities and attitudes, certain limitations of the study must be mentioned. First, the sample was composed predominately of European-American adolescents from middle-class families in central Pennsylvania. Thus, the current results cannot be used to understand race or ethnic-based differences in computer attitudes and activities, nor can the results necessarily be generalized across adolescents. Future research should attempt to validate the new measures created in the current study on adolescents from more diverse populations.

Moreover, due to the cross-sectional nature of the data, developmental processes and longitudinal relations between constructs cannot be examined. Thus, it is impossible to test whether differences between 9^{th} and 12^{th} graders in the current study, for example, are true developmental differences, cohort differences, or a combination of the two. Future research should attempt to follow multiple cohorts of adolescents cross-sequentially as they move through high school in order to tease apart possible developmental and cohort-based explanations.

Next, all measures in the current study were collected via a survey. Although adolescents' web-based self-reports of their computer activities and attitudes offer interesting information, future research should attempt to collect observational or diary-based reports of adolescents' computer activities as well. It is possible that the adolescents in the current study under- or overestimated the amount of time spent on computer activities since they had to think about their activity-involvement retrospectively. Future researchers could collect both survey-based and daily diary-based data regarding adolescents' computer activities in order to assess the reliability between the two methods.

In addition, the current study only provides information regarding students' *attitudes* about seven computer careers; no data is available on the actual careers these adolescents will eventually enter. Although the examination of adolescents' reports of interest and efficacy for various IT careers offers a first important step in explaining gender differences in the IT workforce, future research should attempt to follow adolescents and young adults as they enter the workplace. Such study designs would allow researchers to examine the relations between adolescents' computer attitudes and actual occupational choices. In addition, many young adults switch from one college major to another, or change career paths due to multiple factors (e.g., changing interests, conflicts with family life, perceived discrimination). Research that follows young adults on their educational and occupational pathways has the potential to help researchers understand why some individuals may choose to leave careers in the IT workforce, for example, even if they indicated interest in the field during high school.

Moreover, the questions used to assess computer career interest and efficacy were general and not presented in the context of certain areas of work, possibly affecting the way adolescents answered the items. The general descriptions provided in the survey may have conjured up ideas of working for IBM or Microsoft, rather than jobs within adolescents' chosen areas of career interest. For instance, the survey generally asked adolescents how interested they were in having a job in web development, rather than asking them if they were interested in designing websites for a particular type of company or industry. It is possible that adolescents would have indicated higher levels of interest if the computer careers were presented in the context of specific areas of work, such as health care, education, or business.

Finally, it is important to discuss the general advantages and disadvantages of using a web-based survey with adolescents in a school environment. Overall, the use of a web-based survey had many advantages over the traditional paper-pencil survey, for both the researcher and the participants. The use of the web-based survey helped avoid the costs associated with printing surveys and offered an extra sense of anonymity to survey participants. Because the current study included a large sample of students, the web-based survey was also very efficient with regard to data management; data for each participant was emailed to the principal investigator after completion of the survey, both increasing data accuracy and decreasing the time and resources associated with data entry. Finally, students enjoyed taking the web-based survey; the format of the questionnaire was different from the paper-pencil surveys students most commonly take, and allowed students to leave their routine classroom environments and visit school computer labs.

The major disadvantage of using the web-based survey was the increased amount of time spent on the front end of the project. First of all, designing the questionnaire template required the use of HTML, making the project more complicated than a regular paper-pencil survey. In addition, visits had to be made with technology personnel and computer lab staff members prior to data collection, in order to make sure that the survey was compatible with the school Internet blocking software and computer systems. Finally, the dates and times of data collection had to be scheduled around computer lab availability and were constrained by the number of computers situated in each lab space. Overall though, the advantages of using a web- based survey greatly outweighed the time spent on these front end tasks.

Ethnic and Income-Based Differences in Computer Access

While the crux of the current study was to examine and understand *gender* differences in the computer and technology workforce, it is important to understand that ethnic and income-based differences in computer use and access exist, and should be considered in future research that focuses on computers and technology. Unfortunately, the ethnic/racial and SES composition of the current sample did not allow for examination of such differences. However, these factors are important and should be studied in future research endeavors.

Although research examining ethnic differences in computer-related *attitudes* is only in its infancy, research has begun to examine ethnic and income-based differences in computer *access* and *use* during adolescence. Overall, compared to European-Americans, African-Americans and Latinos are less likely to own a home computer, report having less access to the Internet, and are less likely to use computers in their jobs (Hoffman & Novak, 1998; McConnaughey & Lader, 1998). Family income levels, however, seem to explain many of these ethnic differences in computer access; in fact, increasing levels of income correspond to an increased likelihood of owning a home computer, regardless of race or ethnicity (Borzekowski & Rickert, 2001; Hoffman & Novak, 1998). In households with an average annual income greater than $75,000, there are no significant differences between White, African-American, and Latino families with regard to computer ownership (McConnaughey & Lader, 1998).

This income-based trend is especially evident in regard to adolescents' computer access. Hoffman and Novak (1998) found no differences among European-American and African-American students' computer use when students had similar income levels and had computer access at home. Moreover, Borzekowski and Rickert (2001) were surprised by the relatively high access and comfort levels of disadvantaged, ethnic minority NYC youth. Their study suggested that less privileged youth manage to gain access to technology and the Internet.

Other research, however, indicates that ethnic differences in computer access exist even after adjusting for income and education. This "digital divide" between ethnic groups becomes most apparent at lower income levels. For instance, Babb (1998) found that rates of home computer ownership and Internet use were lower among low-income African-Americans and Latinos than among European-Americans at the same income level. Similarly, among students in low-income homes without home computer access, European-American students are much more likely than African-American students to have used the Internet (Hoffman & Novak, 1998). Moreover, although Hoffman, Novak, and Schlosser's (2000) findings reveal evidence of an income-based digital divide for both European-Americans and African-Americans, with the wealthiest individuals reporting the most computer access, the effects of income were significantly more pronounced for African-American families. Importantly, however, recent findings (Hoffman et al., 2000) suggest that the overall gap between European-Americans and African Americans in computer use and access have clearly been decreasing over time.

Although the gender gap in the computer workforce is striking, the under-representation of African-American and Latino individuals in technology careers is even more evident (NSF, 2004). In light of the mixed findings in past research with regard to ethnic and race-based differences in adolescents computer access, attitudes, and activities, as well as the aforementioned under-representations in the IT workforce, it remains an important task for future researchers to more closely examine these variables in ethnically diverse populations.

Implications and Conclusions

More then a decade ago, a study was published suggesting that boys were more likely to see the computer as a playful toy, whereas girls viewed the computer as a tool to accomplish clerical tasks (Giacquinta et al., 1993). Although boys still play games at higher rates than girls, many gender differences in adolescents' computer activities have disappeared. Most adolescents, regardless of gender, realize that computers are useful tools, helping them to communicate with others and finish their homework assignments. The current study also shows that both male and female adolescents use the computer for numerous recreational activities as well, often spending more than two hours a day in front their computer screens. Now that both male and female adolescents use the computer for multiple utility tasks and recreational activities, the original "toy vs. tool" hypothesis has become too simplistic and will not help us understand or begin to close the gender gap in the technology workforce. The current study offers a detailed look into the evolving ways adolescents use computer technology, as well as the associations between activity-involvement and technology-related career beliefs.

Past research (e.g., Jacobs, Finken, Griffin, & Wright, 1998) has successfully applied Eccles' and colleagues' (1983) expectancy-value model to other achievement domains, resulting in explanations for the gender gaps in related areas of math and science. These findings have led to the development of successful programs and interventions (e.g., Expanding Your Horizons) that have encouraged more women to attain careers in areas such as medicine and biology. Findings from the present study could be applied in similar interventions, focused on computers and technology, and could also have strong implications for how educators introduce concepts and computer-related educational activities in the classroom.

For instance, the current findings suggest that young women are especially interested in careers that involve web development. In order to increase the number of female students in computer courses, schools may want to offer more classes that deal specifically with web design and web development, and school counselors should encourage female students to enroll in these classes during the first years of high school, or perhaps even earlier. The teachers who instruct these courses may want to emphasize creativity, as well as the "people and society-oriented" applications of web-design, helping students to see connections between careers in technology and the types of career characteristics they value most.

In addition, computer troubleshooting, helping others with computer problems, spending computer time with friends, and the presence of high levels of computer self-confidence are all related to interest and efficacy for computer careers. Thus, computer teachers may want to include mini-lessons in their courses, focused on giving students hands-on solutions to common computer errors and bugs. Teachers could help students become well-versed in the skills necessary to become good troubleshooters, helping to raise their self-confidence and enabling them to help others deal with computer problems. As students, especially females, realize that their computer skills make it possible for them to help others with computer issues and errors, they may develop higher degrees of interest and efficacy for computer careers.

In fact, a current collaborative effort between several U.S. high-tech companies and the National Science Foundation aims to revamp material included in college-level computer courses, in order to make them more attractive to female students. Based on pilot programs with high retention rates among female participants, experts from the collaborative project suggest that computer courses should include hands-on experiences that teach students how to help others using their computer knowledge. They argue that females, especially, need to learn the relevance of the field early, and see connections between technology and making a difference in the world (McDonald, 2004). Although these changes to college-level computer courses are certainly a step in the right direction, the results of the current study suggest that such changes need to be made to computer courses much earlier, perhaps during the first year of high school.

Similarly, in light of the positive relationship between computer activities with friends and reports of computer career interest and efficacy, computer teachers may also want to encourage students to work in groups, and educate students about computer careers that involve human contact (e.g., educational software design). Working on class projects together and learning about computer careers that involve social contact might help combat adolescents' negative perceptions of the computer workforce, and break down their stereotypes of anti-social computer scientists who sit in front of computers all day. A common image of people who go into the field of computer science is a combination of "geeks, gadgets, and greed." These are the very job characteristics that seem to be especially unattractive to girls (Chaudhry, 2000; Gilbert, 2002). Teachers can certainly help entice female students into the field of computer technology by debunking these stereotyped beliefs and exposing students to the wide field of jobs that exist within the IT workforce.

Although gender gaps in many areas of science have narrowed, the gender divide in the IT workforce has actually increased almost every year over the past decade (Cooper & Weaver, 2003). Importantly, women's ideas and contributions to the world of technology are critical to the overall health of the computer industry and a variety of other technology-driven industries; women's inclusion in these fields will help ensure that a variety of perspectives are included in product design and application (Margolis & Fisher, 2003; McDonald, 2004).

In the words of the late Dr. Anita Borg, president and founding director of the Institute for Women and Technology, "We are at a point where everything is changing incredibly rapidly. Technology is a huge driver of that change. We have lots of choices about how it gets created and how it gets used. Women have to be there helping make that choice, or we will just get left out" (Chaudhry, 2000). The theoretical and educational implications provided in the current study have the potential to help both female and male adolescents enter the IT workforce, so that both women and men will have a voice in the future evolution of technology.

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Appendix A: Tables and Figures

Table 1

Computer-related Career Beliefs

Imagine you are getting ready to start working and are choosing the job or career you will be in for several years. Look at the following list of *computer-related jobs* and respond to the questions underneath each description:

List of occupations: Computer scientist, Computer systems analyst, Webmaster, Web developer/designer, Database administrator, Computer Support Services, Computer Teacher

How **interested** are you in this occupation?	1 (not very) – 7 (very)
How **likely** are you to enter this occupation?	1 (not very) – 7 (very)
How **well** would you perform in this occupation?	1 (not very) – 7 (very)

Note: Cronbach's Alpha = .87 (Interest); .90 (Likelihood); .91 (Efficacy). These items are based on job descriptions from the U.S. Department of Labor (Bureau of Labor Statistics, 2003).

Table 2

Computer Anxiety Scale (CAS; Selwyn, 1997)

Scale/Item	Response rating scale anchors
If given the opportunity to use a computer, I am afraid that I might damage it in some way.	1 (strongly disagree) – 5 (strongly agree)
I hesitate to use a computer in case I look stupid.	
I feel apprehensive about using a computer.	
Using a computer does not scare me at all.[R]	
I hesitate to use a computer for fear of making mistakes I cannot correct.	
Computers make me feel uncomfortable.	

Note: Cronbach's Alpha = .88; [R] indicates items that were reverse scored.

Table 3

Computer Attitudes and Self-Confidence Questionnaire (CASCQ; Levine & Donitsa-Schmidt, 1997)

Scale/Item	Response rating scale anchors
Value (Cronbach's Alpha = .72)	1 (strongly disagree) – 5 (strongly agree)
People managed before without computers so computers are not necessary now. [R]	
The world would be better off without computers. [R]	
Everyone should know how to use a computer.	
Only people who use computers in their jobs need to learn about computers. [R]	
You can get on in life without knowing about computers. [R]	
Every home should have a computer.	
Self-confidence (Cronbach's Alpha = .85)	
I find using the computer easy.	
I learn more rapidly when I use the computer.	
It would be hard for me to learn to use a computer. [R]	
I learn new computer programs easily.	
I get confused with all the different keys and computer commands. [R]	
I feel uneasy when people talk about computers. [R]	
I feel comfortable working with computers.	
I get anxious each time I need to learn something new about computers. [R]	
Computer studies is one of my best subjects.	
Interest (Cronbach's Alpha = .92)	
I like to learn how to use the computer.	
I enjoy using a computer.	
Computers are fascinating.	
The computer is an educational tool.	
Using the computer in different school subjects makes studying fun.	
The computer is an effective learning tool.	
It is fun figuring out how computers work.	
One can learn new things from a computer.	
Learning about the different uses of computers is interesting.	
Using computers broadens your horizons.	
You can learn a lot from using a computer.	
Enjoyment (Cronbach's Alpha = .74)	
I use the computer when I have nothing else to do.	
Working with a computer is a good way to pass the time.	
I prefer computer games to other games.	
The computer stops me from being bored.	

Note: [R] indicates items that were reverse scored

Table 4

Computer Outcome Expectancy (COE; Riggs & Enochs, 1993)

Scale/Item	**Response rating scale anchors**
If I got better at using the computer, it would help me to do better in school.	1 (strongly disagree) – 5 (strongly agree)
When other students' attitudes towards math improve, it is often due to their having learned how to use the computer.	
Learning how to use the computer well would help me in my classes.	
My success in schoolwork is related to how well I can use a computer.	
Learning how to use a computer can help me.	
Learning to use a computer will not help my future. [R]	
It is not worth my time to use a computer. [R]	
I will probably never use a computer once I leave school. [R]	
It is really not necessary to use a computer. [R]	
Computers can be helpful.	
I might someday make more money if I learn to use a computer.	
Most good jobs do not require computer skills. [R]	
Success in school has nothing to do with being able to use the computer. [R]	

Note: Cronbach's Alpha = .79; [R] indicates items that were reverse scored

Table 5

Computer Gender Stereotypes (Woodrow, 1994)

Scale/Item	Response rating scale anchors
In general, women can do just as well as men in computer careers. [R]	1 (strongly disagree) – 5 (strongly agree)
Studying about computers is just as important for women as for men. [R]	
Using computers is more for men than for women.	
Men generally do better in computer courses than do women.	
Men make better scientists and engineers than women do.	

Note: Cronbach's Alpha = .90; [R] indicates items that were reverse scored

Table 6

Computer Careers and Family Compatibility (Adapted from Barber & Eccles, 2003)

Scale/Item	Response rating scale anchors
	1 (strongly disagree) – 5 (strongly agree)
Careers in computers/technology have flexible work schedules that can be adjusted to meet the needs of one's family.	
Having a career in computer-technology would leave a lot of time for other things in my life.	
A career in computer-technology would allow me to be at home when my children are out of school.	
Having a career in computer-technology would make it easy to take time off for family responsibilities.	
Careers in computer-technology would have good parental leave policies.	

Note: Cronbach's Alpha = .90

Table 7

Computer Expertise

Scale/Item	Response rating scale anchors
	1 (strongly disagree) – 5 (strongly agree)
Preferences (Cronbach's Alpha = .85)	
I spend time configuring the computer to look and act as I want it to.	
I like to personalize my computer preferences.	
When I use new computer software, I like to change the preferences.	
I often customize the templates provided on computer software.	
I can easily change the display properties on a computer.	
I develop shortcuts and more efficient ways to use computers	
I learn new computer tasks by trial and error.	
Troubleshoot (Cronbach's Alpha = .83)	
I enjoy computer programming.	
I like to figure out why computer errors occur.	
If someone asked me how much RAM my computer had, I would know what they were talking about.	
I am always up-to-date on current computer virus protection.	
I understand how to network multiple computers.	
I would rather fix a computer problem myself than have someone else help me out.	
It is important to understand computers from the inside out.	
Need Help (Cronbach's Alpha = .75)	
I usually ask someone else to install new computer software for me.	
When a computer freezes, I just ask someone else to deal with it.	
If I wanted to burn a music CD, I would have to ask someone for help.	
When I have trouble figuring out how to do something on the computer, I give up easily.	
Give Help (Cronbach's Alpha = .83)	
I feel important when others ask me for information about computers.	
Other students look to me for help when using the computer.	
I help my friends when they have problems with computers.	
Helping people with computer problems does not appeal to me. [R]	
I like to assist others on the computer.	
Figuring out computer problems does not appeal to me. [R]	

Note: [R] indicates items that were reverse scored

Table 8

Computer Value

Scale/Item	Response rating scale anchors
	1 (strongly disagree) – 5 (strongly agree)
Computer Affect (Cronbach's Alpha = .80)	
I am interested in finding out about new products that I can use with my computer.	
I feel happy walking into a room filled with computers.	
Computers are interesting in and of themselves.	
It is fun figuring out how computers work.	
Learning about the different uses of computers is interesting.	
Communication (Cronbach's Alpha = .77)	
I value the ability to communicate with friends via computer.	
I only use the Internet when I have to. [R]	
I like the way the Internet keeps me in touch with other people.	
Computers can be used for the benefit of solving social problems.	
Computer as a Tool (Cronbach's Alpha = .83)	
Computers can allow me to do more interesting and imaginative work.	
Computers can enhance the presentation of my work to a degree which justifies the extra effort.	
Computers help me organize my work better.	
I use a computer to save time on work that would take me longer otherwise.	
Computers are a tool to be used to get other things done.	

Note: [R] indicates items that were reverse scored

Table 9

Computer Activity-Involvement (adapted from Kafai & Sutton, 1999)

Scale/Item	Response rating scale anchors
Miscellaneous	
How many hours do you use a computer on a typical day at home?	(none) – (7+ hours)
How often do you use the following software at home?	
Please circle one number for each activity:	
Word processing	(none) – (7+ hours)
Educational programs (like SAT prep)	
Photo/Music/Drawing/Art	
How often are you engaged in the following activities? Please circle one number for each activity:	
Computer programming	(none) – (7+ hours)
Taking apart/fixing computers	
Helping friends/family with computer-related problems	
Computer activities with friends	
School	
How often each day were you engaged in the following activities at school?	(none) – (7+ hours)
Classroom assignments on the computer	
Library research on the computer	
How many computer or technology courses have you taken in high school?	N/A
Computer games	(none) – (7+ hours)
Action Adventure Games	
Computer Puzzles	
Sports Games	
Simulation Games	
Classic Arcade Games	
Non-Computer Video Games	

Internet

During a typical day, how many hours are you engaged in each of the following Internet activities at home?
Please circle one option for each activity:

General Internet Use	(none) – (7+ hours)
Email	
Surfing the net	
Chat rooms/Instant messaging	
Internet research for school	
Downloading music	
On-line shopping/Ebay	
On-line games	
Webpage development	
Blogging, on-line diaries	
Listserves, on-line groups	

Table 10.

Means, Standard Deviations, and MANOVA Tests for School-based Differences in Computer Activities (9^{th} grade only; N = 261)

	State College		Penns Valley			
	Mean	**SD**	**Mean**	**SD**	**F**	**Partial η^2**
Miscellaneous						
Overall Time on Computer at Home	2.24	1.72	2.29	1.83	0.00	
Word Processing	0.94	1.06	0.97	1.08	0.45	
Educational Programs	0.18	0.68	0.06	0.26	1.56	
Photo/Music/Drawing/Art	0.76	1.19	1.06	1.66	2.27	
Computer Programming	0.28	0.98	0.33	1.07	0.22	
Taking Apart/Fixing Computers	0.22	0.88	0.18	0.54	0.00	
Helping friends/family with Computers	0.29	0.81	0.47	1.18	2.33	
Computer Activities with Friends	0.65	1.21	0.89	1.45	1.75	
Omnibus					1.10	
School						
Classroom assignments on Computer	0.70	1.00	1.18	0.91	11.38***	.05
Library research on Computer	0.40	0.63	0.58	0.87	3.38	
Courses	0.58	1.30	1.92	0.67	58.27***	.21
Omnibus					22.51***	.23
Games						
Action Adventure Games	0.56	1.33	0.67	1.61	0.14	
Computer Puzzles	0.38	0.79	0.51	1.18	1.56	
Sports Games	0.37	1.00	0.56	1.44	2.54	
Simulation Games	0.41	0.99	0.57	1.25	1.40	
Classic Arcade Games	0.20	0.37	0.38	1.00	3.96*	.02
Non-Computer Video Games	1.10	1.67	1.29	1.93	0.03	

Games Added together	2.94	3.86	3.89	6.09	2.14
Omnibus					0.83
Internet					
General Internet Use	1.84	1.80	2.16	2.17	1.48
Email	0.59	0.94	0.53	0.87	0.07
Listserves	0.21	0.76	0.28	0.89	0.35
Surfing the Net	0.96	1.16	0.95	1.23	0.28
Chatrooms/IM	1.53	1.55	1.63	1.90	0.86
Internet Research for School	0.69	0.86	0.85	0.86	3.56
Download Music	0.70	1.30	0.80	1.67	0.60
Online Activities at School	0.23	0.64	0.13	0.44	1.10
Online Shopping	0.29	0.76	0.34	0.84	0.03
Online Games	0.67	1.37	0.65	1.44	0.00
Webpage Development	0.21	0.81	0.21	0.94	0.00
Blogging	0.21	0.78	0.06	0.26	2.56
Internet activities added together	17.17	6.19	17.62	5.36	0.10
Omnibus					1.47

Table 11

Means, Standard Deviations, and MANOVA Tests for Gender Differences in Computer Activities (N =460)

	Females		**Males**			
	Mean	**SD**	**Mean**	**SD**	**F**	**Partial η^2**
Miscellaneous						
Overall Time on Computer at Home	2.23	1.79	2.27	1.79	0.06	
Word Processing	1.25	1.19	0.95	1.14	8.49**	.02
Educational Programs	0.20	0.73	0.10	0.51	7.00**	.02
Photo/Music/Drawing/Art	0.96	1.48	0.95	1.53	0.03	
Computer Programming	0.13	0.67	0.34	1.06	7.23**	.02
Taking Apart/Fixing Computers	0.15	0.64	0.28	0.88	4.72*	.01
Helping friends/family with Computers	0.26	0.75	0.38	0.88	2.25	
Computer Activities with Friends	0.65	1.21	0.89	1.45	3.87*	.01
Omnibus					3.32***	.06
School						
Classroom assignments on Computer	0.67	0.71	0.88	1.27	4.96*	.01
Library research on Computer	0.40	0.54	0.37	0.82	.48	
Number of courses	0.85	1.26	1.75	2.01	86.04***	.07
Omnibus					11.37***	.08
Games						
Action Adventure Games	0.14	0.63	1.08	1.86	51.64***	.11
Computer Puzzles	0.43	0.67	0.46	1.21	0.28	
Sports Games	0.15	0.61	0.65	1.49	24.39***	.05
Simulation Games	0.40	1.06	0.39	1.01	0.01	
Classic Arcade Games	0.22	0.48	0.33	0.94	2.15	

Non-Computer Video Games	0.42	0.91	1.94	2.18	83.71***	.16
Games Added together	1.66	2.45	4.75	6.25	44.43***	.09
Omnibus					18.42***	.21
Internet						
General Internet Use	2.18	2.07	1.92	1.88	1.42	
Email	0.61	0.89	0.56	0.85	0.00	
Listserves	0.21	0.75	0.22	0.78	0.03	
Surfing the Net	0.95	1.31	1.11	1.13	3.45	
Chatrooms/IM	1.59	1.70	1.44	1.59	0.52	
Internet Research for School	0.83	0.91	0.67	0.85	3.02	
Download Music	0.74	1.53	0.93	1.64	2.29	
Online Activities at School	0.23	0.76	0.38	0.84	4.03*	.01
Online Shopping	0.25	0.72	0.31	0.80	0.94	
Online Games	0.40	1.16	0.98	1.65	20.39***	.05
Webpage Development	0.14	0.78	0.24	0.83	1.53	
Blogging	0.25	0.89	0.15	0.67	1.46	
Internet activities added together	17.12	6.00	17.73	6.10	2.52	
Omnibus					4.70***	.13

Table 12

Means, Standard Deviations, and MANOVA Tests for Gender Differences in Computer Attitudes (N = 460)

	Females		**Males**			
	Mean	**SD**	**Mean**	**SD**	**F**	**Partial η^2**
Computer Attitudes						
Computer Anxiety	2.05	0.64	2.27	0.78	10.93***	.03
Computer Value	3.57	0.53	3.49	0.66	1.74	
Computer Self-Confidence	3.55	0.58	3.59	0.72	0.27	
Computer Interest	3.46	0.59	3.50	0.72	0.27	
Computer Enjoyment	3.31	0.74	3.35	0.75	0.35	
Computer Outcome Expectancy	3.46	0.47	3.46	0.54	0.01	
Omnibus Test					3.17**	.05
Gender Belief Scales						
Computer Gender Stereotypes	1.72	0.71	2.53	1.01	95.41***	.18
Computer Career/Family Compatibility	3.08	0.60	3.07	0.65	0.03	
Omnibus Test					47.62***	.18
Computer Expertise						
Preferences	3.32	0.70	3.40	0.81	0.54	
Troubleshoot	2.44	0.69	2.92	0.88	24.23***	.08
Need Help	2.63	0.81	2.19	0.86	21.17***	.07
Give Help	2.80	0.75	2.95	0.79	2.29*	.01
Omnibus Test					19.21***	.15
Computer Value						
Computer Affect	2.99	0.68	3.23	0.74	10.65***	.02
Computer as a Tool	3.71	0.66	3.67	0.78	0.15	

Communication	3.84	0.72	3.68	0.82	5.00*	.01
Omnibus Test					8.82***	.06

Table 13

Means, Standard Deviations, and MANOVA Tests for Gender Differences in Computer Career Beliefs (N = 460)

	Females		Males			
Averaged Across Careers	**Mean**	**SD**	**Mean**	**SD**	**F**	**Partial η^2**
Comp Career Interest	2.11	1.00	2.38	1.26	6.99**	.02
Comp Career Likelihood	1.70	0.86	1.96	1.15	7.28**	.02
Comp Career Efficacy	2.68	1.29	3.30	1.63	20.10***	.04
Omnibus Test					7.00***	.05
Specific Computer Careers						
Computer Science Interest	2.31	1.50	3.10	1.93	18.08***	.04
Computer Science Likelihood	1.73	1.20	2.23	1.63	11.69***	.03
Computer Science Efficacy	2.98	1.70	3.75	1.91	17.54***	.04
Systems Analyst Interest	1.94	1.19	2.59	1.73	15.62***	.04
Systems Analyst Likelihood	1.61	1.02	2.07	1.55	8.43***	.02
Systems Analyst Efficacy	2.60	1.58	3.48	1.93	21.35***	.05
Database Administrator Interest	1.65	1.05	1.97	1.46	4.76*	.01
Database Administrator Likelihood	1.50	0.94	1.74	1.28	4.23*	.01
Database Administrator Efficacy	2.18	1.50	2.88	1.96	16.23***	.04
Webmaster Interest	2.21	1.44	2.45	1.74	1.95	
Webmaster Likelihood	1.73	1.08	2.02	1.50	3.57	
Webmaster Efficacy	2.67	1.64	3.50	2.05	16.98***	.04
Web Developer Interest	2.86	1.68	2.72	1.80	1.76	

Web Developer Likelihood	2.11	1.43	2.22	1.58	0.02	
Web Developer Efficacy	3.37	1.86	3.44	2.02	0.10	
Computer Support Services Interest	1.69	1.13	1.90	1.40	2.34	
Computer Support Services Likelihood	1.46	0.89	1.69	1.31	2.92	
Computer Support Services Efficacy	2.20	1.51	2.96	1.94	17.46***	.04
Computer Teacher Interest	2.16	1.52	1.96	1.45	1.42	
Computer Teacher Likelihood	1.79	1.21	1.75	1.28	0.06	
Computer Teacher Efficacy	2.81	1.79	3.15	2.05	3.47*	.01
Omnibus Test					3.60***	.17

Table 14

Means and Standard Deviations for Computer Activity-Involvement by Gender and Grade (HS 1 only; N = 378)

	Females		**Males**	
	Mean	**SD**	**Mean**	**SD**
Miscellaneous				
Overall Time on Computer at Home				
Grade 9	2.36	1.77	2.14	1.72
Grade 12	1.83	1.82	2.50	2.06
Word Processing				
Grade 9	1.05	1.01	0.82	1.12
Grade 12	1.47	1.03	0.86	0.86
Educational Programs				
Grade 9	0.18	0.76	0.10	0.28
Grade 12	0.27	0.65	0.05	0.15
Photo/Music/Drawing/Art				
Grade 9	0.98	1.44	0.69	1.21
Grade 12	0.83	1.30	1.08	1.54
Computer Programming				
Grade 9	0.18	0.81	0.44	1.19
Grade 12	0.03	0.13	0.23	0.87
Taking Apart/Fixing Computers				
Grade 9	0.19	0.76	0.24	0.84
Grade 12	0.69	0.32	0.31	0.78
Helping friends/family with Computers				
Grade 9	0.31	0.85	0.39	1.03
Grade 12	0.23	0.61	0.34	0.73

Computer Activities with Friends				
Grade 9	0.68	1.21	0.62	0.97
Grade 12	0.67	1.43	1.17	1.92
School				
Classroom assignments on Computer				
Grade 9	0.79	0.75	0.89	1.25
Grade 12	0.34	0.30	0.77	1.02
Library research on Computer				
Grade 9	0.44	0.55	0.46	0.87
Grade 12	0.19	0.25	0.15	0.27
Number of courses				
Grade 9	0.79	1.17	1.14	1.45
Grade 12	1.09	1.67	2.60	2.45
Games				
Action Adventure Games				
Grade 9	0.16	0.61	1.15	1.86
Grade 12	0.03	0.23	1.20	2.10
Computer Puzzles				
Grade 9	0.40	0.62	0.44	1.19
Grade 12	0.56	0.92	0.43	1.20
Sports Games				
Grade 9	0.18	0.67	0.72	1.50
Grade 12	0.08	0.53	0.60	1.57
Simulation Games				
Grade 9	0.51	1.21	0.38	0.88
Grade 12	0.10	0.28	0.37	1.02

Classic Arcade Games				
Grade 9	0.23	0.46	0.28	0.78
Grade 12	0.14	0.35	0.38	1.00
Non-Computer Video Games				
Grade 9	0.41	0.73	2.07	2.15
Grade 12	0.35	0.73	1.97	2.36
Games Added together				
Grade 9	1.74	2.18	5.08	6.02
Grade 12	1.26	2.14	4.71	6.28
Internet				
General Internet Use				
Grade 9	2.21	2.06	1.59	1.68
Grade 12	2.07	2.07	2.21	1.98
Email				
Grade 9	0.61	0.99	0.53	0.83
Grade 12	0.53	0.35	0.64	1.00
Listserves				
Grade 9	0.20	0.79	0.27	0.81
Grade 12	0.24	0.64	0.25	0.92
Surfing the Net				
Grade 9	0.90	1.27	1.02	1.07
Grade 12	0.83	0.68	1.17	1.17
Chatrooms/IM				
Grade 9	1.77	1.76	1.31	1.48
Grade 12	1.09	1.34	1.59	1.77
Internet Research for School				
Grade 9	0.78	0.88	0.67	0.84
Grade 12	0.84	0.78	0.56	0.88

Download Music				
Grade 9	0.73	1.48	0.72	1.34
Grade 12	0.70	1.48	1.28	2.02
Online Activities at School				
Grade 9	0.19	0.69	0.23	0.46
Grade 12	0.24	0.31	0.57	1.03
Online Shopping				
Grade 9	0.27	0.79	0.35	0.78
Grade 12	0.23	0.45	0.33	0.99
Online Games				
Grade 9	0.39	1.11	0.99	1.61
Grade 12	0.40	1.19	0.96	1.83
Webpage Development				
Grade 9	0.14	0.82	0.29	0.88
Grade 12	0.03	0.13	0.25	0.94
Blogging				
Grade 9	0.21	0.82	0.12	0.44
Grade 12	0.16	0.30	0.17	0.89
Internet activities added together				
Grade 9	17.01	6.08	17.64	5.83
Grade 12	16.93	4.20	18.04	7.00

Table 15

Means and Standard Deviations for Computer Attitudes by Gender and Grade (HS 1 only; N = 378)

	Females		**Males**	
	Mean	**SD**	**Mean**	**SD**
Computer Attitudes				
Computer Anxiety				
Grade 9	2.12	0.64	2.35	0.76
Grade 12	1.93	0.60	2.19	0.73
Computer Value				
Grade 9	3.53	0.55	3.47	0.62
Grade 12	3.67	0.48	3.45	0.71
Computer Self-Confidence				
Grade 9	3.55	0.57	3.43	0.70
Grade 12	3.54	0.60	3.74	0.71
Computer Interest				
Grade 9	3.48	0.60	3.44	0.73
Grade 12	3.39	0.64	3.50	0.74
Computer Enjoyment				
Grade 9	3.40	0.68	3.24	0.69
Grade 12	3.16	0.79	3.42	0.76
Computer Outcome Expectancy				
Grade 9	3.48	0.49	3.49	0.55
Grade 12	3.38	0.45	3.40	0.58
Gender Belief Scales				
Gender Stereotypes				
Grade 9	1.72	0.73	1.75	0.68
Grade 12	2.40	0.93	2.77	1.10

Computer Career/Family Compatibility				
Grade 9	3.09	0.59	3.06	0.65
Grade 12	3.06	0.67	3.08	0.63
Computer Expertise				
Preferences				
Grade 9	3.34	0.64	3.23	0.84
Grade 12	3.24	0.81	3.50	0.78
Troubleshoot				
Grade 9	2.46	0.65	2.76	0.87
Grade 12	2.39	0.78	2.98	0.88
Need Help				
Grade 9	2.62	0.79	2.39	0.88
Grade 12	2.62	0.87	2.02	0.73
Give Help				
Grade 9	2.88	0.70	2.89	0.77
Grade 12	2.52	0.83	2.95	0.80
Value				
Computer Affect				
Grade 9	3.03	0.67	3.15	0.77
Grade 12	2.82	0.72	3.23	0.73
Computer as a Tool				
Grade 9	3.66	0.64	3.57	0.78
Grade 12	3.72	0.81	3.64	0.82
Communication				
Grade 9	3.92	0.69	3.57	0.80
Grade 12	3.57	0.82	3.76	0.83

Table 16

Means and Standard Deviations for Computer Career Beliefs by Gender and Grade (HS 1 only; N = 378)

	Females		**Males**	
	Mean	**SD**	**Mean**	**SD**
Averaged Across Careers				
Comp Career Interest				
Grade 9	2.11	1.02	2.42	1.35
Grade 12	1.96	0.93	2.38	1.23
Comp Career Likelihood				
Grade 9	1.73	0.93	2.01	1.27
Grade 12	1.58	0.78	1.93	1.04
Comp Career Efficacy				
Grade 9	2.72	1.29	3.20	1.63
Grade 12	2.48	1.39	3.53	1.71
Specific Computer Careers				
Computer Science Interest				
Grade 9	2.36	1.52	3.01	1.90
Grade 12	2.14	1.53	3.15	1.93
Computer Science Likelihood				
Grade 9	1.82	1.31	2.16	1.55
Grade 12	1.52	0.98	2.24	1.62
Computer Science Efficacy				
Grade 9	3.09	1.68	3.65	1.86
Grade 12	2.70	1.78	3.93	2.00

Systems Analyst Interest				
Grade 9	1.88	1.19	2.56	1.72
Grade 12	1.93	1.30	2.60	1.79
Systems Analyst Likelihood				
Grade 9	1.60	1.02	2.08	1.62
Grade 12	1.67	1.17	2.03	1.41
Systems Analyst Efficacy				
Grade 9	2.65	1.55	3.34	1.89
Grade 12	1.67	1.17	2.03	1.41
Database Administrator Interest				
Grade 9	1.57	0.99	2.06	1.62
Grade 12	1.56	0.93	1.94	1.38
Database Administrator Likelihood				
Grade 9	1.49	0.98	1.79	1.43
Grade 12	1.45	0.87	1.77	1.21
Database Administrator Efficacy				
Grade 9	2.17	1.44	2.90	2.00
Grade 12	2.12	1.66	3.12	1.97
Webmaster Interest				
Grade 9	2.14	1.40	2.45	1.77
Grade 12	2.14	1.42	2.56	1.83
Webmaster Likelihood				
Grade 9	1.73	1.10	2.07	1.64
Grade 12	1.72	1.12	2.03	1.42
Webmaster Efficacy				
Grade 9	2.63	1.55	3.33	2.06
Grade 12	2.64	1.92	3.74	1.99

Web Developer Interest				
Grade 9	2.86	1.71	2.75	1.89
Grade 12	2.48	1.41	2.73	1.78
Web Developer Likelihood				
Grade 9	2.16	1.49	2.29	1.68
Grade 12	1.77	1.14	2.17	1.50
Web Developer Efficacy				
Grade 9	3.40	1.86	3.38	2.07
Grade 12	2.98	1.85	3.65	1.99
Computer Support Services Interest				
Grade 9	1.70	1.44	1.98	1.47
Grade 12	1.60	1.26	1.83	1.33
Computer Support Services Likelihood				
Grade 9	1.49	0.95	1.77	1.42
Grade 12	1.33	0.71	1.64	1.17
Computer Support Services Efficacy				
Grade 9	2.20	1.15	2.85	1.83
Grade 12	2.21	1.69	3.11	2.06
Computer Teacher Interest				
Grade 9	2.27	1.56	2.07	1.54
Grade 12	1.84	1.40	1.84	1.47
Computer Teacher Likelihood				
Grade 9	1.87	1.31	1.84	1.32
Grade 12	1.59	1.00	1.63	1.18
Computer Teacher Efficacy				
Grade 9	3.01	1.82	2.93	1.95
Grade 12	2.31	1.67	3.53	2.09

Table 17

Hierarchical Regression Analysis for Variables Predicting Adolescents' Computer Career Interest

Variable	B	SE β	β
Step 1			
Adolescent Sex	0.32	0.12	0.14**
Age	-0.04	0.05	-0.05
School	-0.11	0.17	-0.04
Home Computers	0.08	0.04	0.10
Step 2			
Adolescent Sex	0.19	0.13	0.08
Age	-0.04	0.04	-0.05
School	-0.19	0.16	-0.06
Home Computers	0.01	0.04	0.02
Computer Outcome Expectancy	0.45	0.17	0.20**
Gender Stereotypes	0.09	0.07	0.07
Value	-0.43	0.12	-0.22***
Self-Confidence	0.05	0.11	0.03
Interest	0.57	0.12	0.33***
Value X Sex	0.04	0.19	0.01
Gender Stereotypes X Sex	0.11	0.14	0.00
Step 3			
Adolescent Sex	0.10	0.13	0.04
Age	-0.02	0.04	-0.03
School	-0.18	0.15	-0.06
Home Computers	-0.02	0.04	-0.03
Computer Outcome Expectancy	0.40	0.17	0.18*
Gender Stereotypes	0.06	0.07	0.05
Value	-0.39	0.12	-0.21***
Self-Confidence	0.00	0.11	0.00
Interest	0.53	0.12	0.31***
Value X Sex	0.04	0.19	0.01
Gender Stereotypes X Sex	0.12	0.13	0.05
Time on Games	0.02	0.03	0.03
Time Programming	0.28	0.07	0.19***
Time with friends on computers	0.13	0.05	0.14**

Note. N = 384; R^2 = .03 for Step 1; ΔR^2 = .16 for Step 2; ΔR^2 = .06 for Step 3 (ps < .05).
* p < .05; ** p < .01; *** p < .001

Table 18

Hierarchical Regression Analysis for Variables Predicting Adolescents' Computer Career Interest

Variable	B	SE β	β
Step 1			
Adolescent Sex	0.27	0.12	0.12*
Age	-0.03	0.04	-0.04
School	-0.05	0.17	-0.02
Home Computers	0.07	0.04	0.10
Step 2			
Adolescent Sex	0.02	0.11	0.01
Age	-0.06	0.04	-0.07
School	-0.16	0.15	-0.05
Home Computers	-0.02	0.04	-0.03
Computer Affect	0.30	0.10	0.20***
Troubleshoot	0.41	0.08	0.29***
Computer Career/Family Compatibility	0.17	0.09	0.09+
CCFC X Sex	0.38	0.17	0.10*
Step 3			
Adolescent Sex	-0.12	0.12	-0.05
Age	-0.08	0.04	-0.10
School	-0.26	0.16	-0.08
Home Computers	-0.04	0.04	-0.05
Computer Affect	0.31	0.10	0.19***
Troubleshoot	0.35	0.09	0.25***
Computer Career/Family Compatibility (CCFC)	0.17	0.09	0.09*
CCFC X Sex	0.32	0.17	0.08+
Time on Games	0.02	0.02	0.04
Courses	0.08	0.03	0.13*
Time Programming	0.18	0.08	0.11*

Note. N = 379; R^2 = .03 for Step 1; ΔR^2 = .21 for Step 2; ΔR^2 = .03 for Step 3 (ps < .05).
+ p < .10; * p < .05; ** p < .01; *** p < .001

Table 19

Hierarchical Regression Analysis for Variables Predicting Adolescents' Computer Career Efficacy

Variable	B	SE β	β
Step 1			
Adolescent Sex	0.56	0.16	0.18***
Age	0.01	0.06	0.01
School	-0.08	0.22	-0.02
Home Computers	0.12	0.05	0.12*
Step 2			
Adolescent Sex	0.41	0.16	0.13**
Age	-0.02	0.06	-0.02
School	-0.19	0.20	-0.05
Home Computers	0.00	0.05	0.00
Computer Outcome Expectancy	0.47	0.22	0.16*
Gender Stereotypes	0.11	0.09	0.07
Value	-0.48	0.16	-0.19***
Self-Confidence	0.56	0.14	0.24***
Interest	0.50	0.15	0.22***
Value X Sex	0.18	0.25	0.04
Gender Stereotypes X Sex	0.38	0.18	0.11*
Step 3			
Adolescent Sex	0.33	0.16	0.11*
Age	0.01	0.05	0.01
School	-0.17	0.20	-0.04
Home Computers	-0.03	0.05	-0.03
Computer Outcome Expectancy	0.44	0.21	0.15*
Gender Stereotypes	0.08	0.09	0.05
Value	-0.45	0.15	-0.18***
Self-Confidence	0.53	0.13	0.23***
Interest	0.46	0.15	0.20***
Value X Sex	0.18	0.24	0.04
Gender Stereotypes X Sex	0.40	0.17	0.12*
Time on Games	-0.01	0.03	-0.02
Time Programming	0.40	0.09	0.20***
Time with friends on computers	0.12	0.06	0.10*

Note. N = 383; R^2 = .05 for Step 1; ΔR^2 = .19 for Step 2; ΔR^2 = .05 for Step 3 (ps < .001).
* $p < .05$; ** $p < .01$; *** $p < .001$

Table 20

Hierarchical Regression Analysis for Variables Predicting Adolescents' Computer Career Efficacy

Variable	B	SE β	β
Step 1			
Adolescent Sex	0.64	0.16	0.21***
Age	0.00	0.06	0.00
School	0.01	0.23	0.00
Home Computers	0.12	0.05	0.12*
Step 2			
Adolescent Sex	0.18	0.16	0.06
Age	-0.08	0.05	-0.08
School	-0.22	0.21	-0.05
Home Computers	-0.06	0.05	-0.06
Self-Confidence	0.41	0.13	0.14***
Troubleshoot	0.77	0.11	0.40***
Gender Stereotypes	0.09	0.09	0.06
Gender Stereotypes X Sex	0.37	0.17	0.11*
Step 3			
Adolescent Sex	0.12	0.17	0.04
Age	-0.11	0.05	-0.10*
School	-0.35	0.21	-0.08
Home Computers	-0.08	0.05	-0.08
Self-Confidence	0.37	0.13	0.15***
Troubleshoot	0.60	0.11	0.32***
Gender Stereotypes	0.07	0.08	0.05
Gender Stereotypes X Sex	0.42	0.16	0.12**
Time on Games	0.02	0.03	0.02
Courses	0.10	0.04	0.11*
Time Programming	0.19	0.11	0.08
Time Helping Friends and Family	0.33	0.14	0.12*

Note. N = *379;* $R^2 = .06$ for Step 1; $\Delta R^2 = .23$ for Step 2; $\Delta R^2 = .04$ for Step 3 (ps < .001).
* p < .05;   ** p < .01;   *** p < .001

Table 21

Means and Standard Deviations for Computer Activities by Cluster

	Cluster 1 Techno-Gamers (N=83)		**Cluster 2** Web Surfers (N=78)		**Cluster 3** Moderates (N=221)		**Overall Sample** (N=382)		
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Range
Computer games	6.24	1.57	1.70	1.64	1.08	1.05	2.40	2.46	0-7
Creative Activities	1.04	1.27	1.88	1.80	0.43	0.72	0.96	1.51	0-7
Internet	2.22	1.94	4.73	1.47	0.98	0.70	2.04	1.98	0-7
Computer programming	0.42	1.19	0.11	0.42	0.10	0.40	0.24	0.90	0-7
Taking apart/fixing computers	0.43	0.97	0.09	0.24	0.06	0.25	0.21	0.77	0-7
Helping friends and family	0.47	0.88	0.33	0.59	0.14	0.30	0.32	0.82	0-7
Computer activities with friends	1.46	1.67	1.20	1.49	0.29	0.51	0.78	1.35	0-7
Word Processing	0.82	0.75	1.54	1.46	0.97	0.95	1.09	1.17	0-7
Computer courses	2.17	2.24	0.97	1.22	1.12	1.61	1.31	1.75	0-8

Table 22

ANOVA: Descriptive Information for Variables Used to Form Cluster Groupings

ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Games	822.567	2	1.471	379	559.314	.000
Photo/music/drawing/art	61.918	2	1.311	379	47.246	.000
Internet	406.852	2	1.539	379	264.413	.000
Computer Programming	3.198	2	.435	379	7.344	.001
Taking apart/Fixing Computers	4.312	2	.249	379	17.318	.000
Helping friends/family with computer	3.678	2	.290	379	12.672	.000
Computer activities with friends	51.910	2	1.203	379	43.150	.000
Courses	38.678	2	2.881	379	13.423	.000
Word Processing	12.452	2	1.074	379	11.597	.000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

Table 23

ANOVA Using Adolescents' Computer Career Interest as the Dependent Variable

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Significance	Partial η^2
Corrected Model	19.15[a]	5	3.83	3.09	.01	.04
Intercept	1241.82	1	1241.82	1000.79	.00	.73
Adolescents' Sex	2.79	1	2.79	2.25	.14	.01
Cluster Membership	10.70	2	5.35	4.31	.01	.02
Sex X Cluster	2.34	2	1.17	0.95	.39	.01
Error	462.83	373	1.24			
Total	2413.82	379				
Corrected Total	481.98	378				

[a] $R^2 = .04$ (Adjusted $R^2 = .03$)

Table 24

ANOVA Using Adolescents' Computer Career Efficacy as the Dependent Variable

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Significance	Partial η^2
Corrected Model	63.46[a]	5	12.69	6.06	.00	.08
Intercept	2235.58	1	2235.58	1066.61	.00	.74
Adolescents' Sex	10.92	1	10.92	5.21	.02	.01
Cluster Membership	26.49	2	13.24	6.32	.00	.03
Sex X Cluster	1.40	2	0.70	0.34	.72	.00
Error	781.80	373	2.10			
Total	4278.63	379				
Corrected Total	845.25	378				

[a] R^2 = .08 (Adjusted R^2 = .06)

Figure 1. Eccles et al. (1983) Expectancy-Value Model of Achievement Motivation

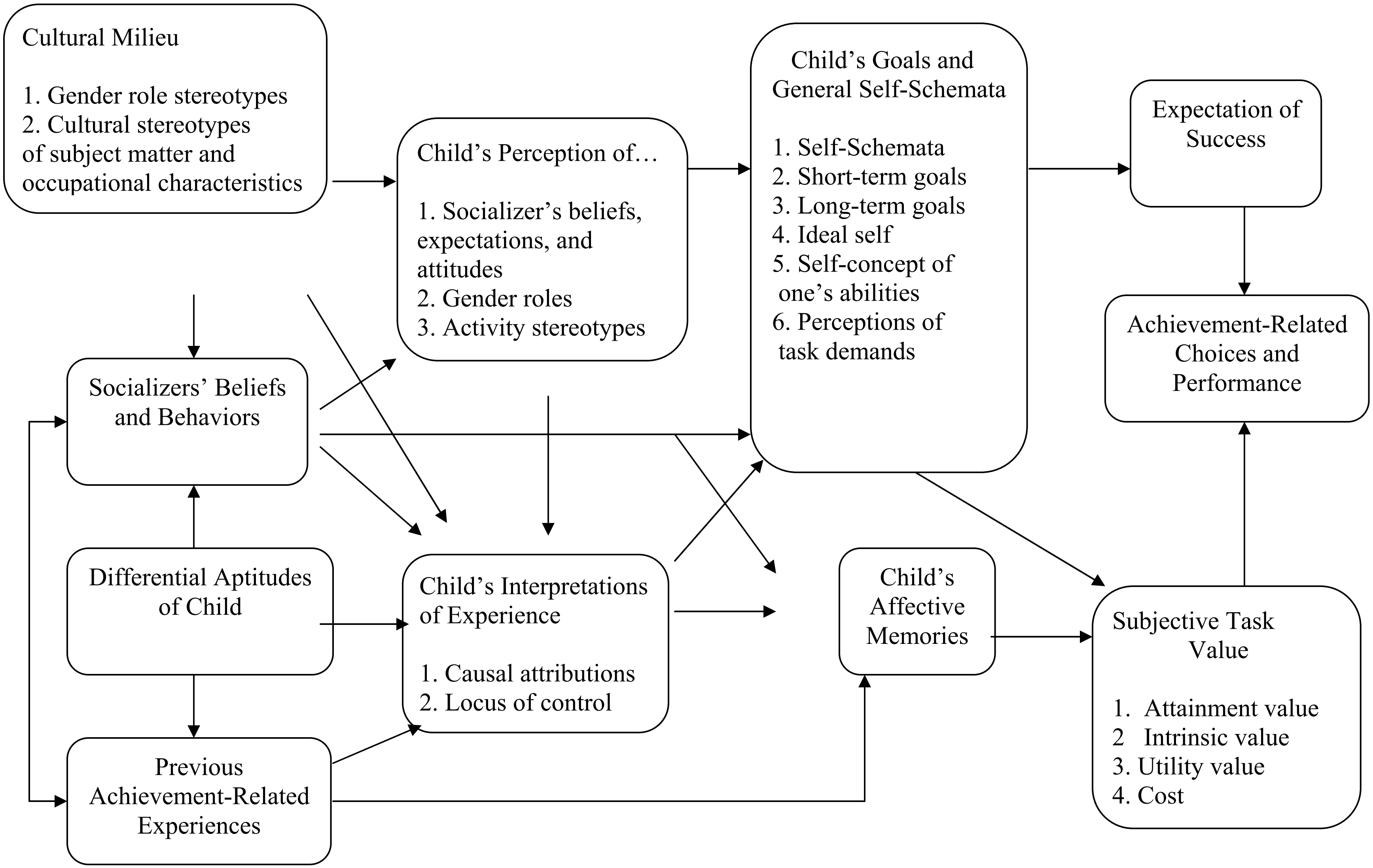


Figure 2. Selected components of Eccles et al. (1983) Expectancy-Value Model of Achievement Motivation

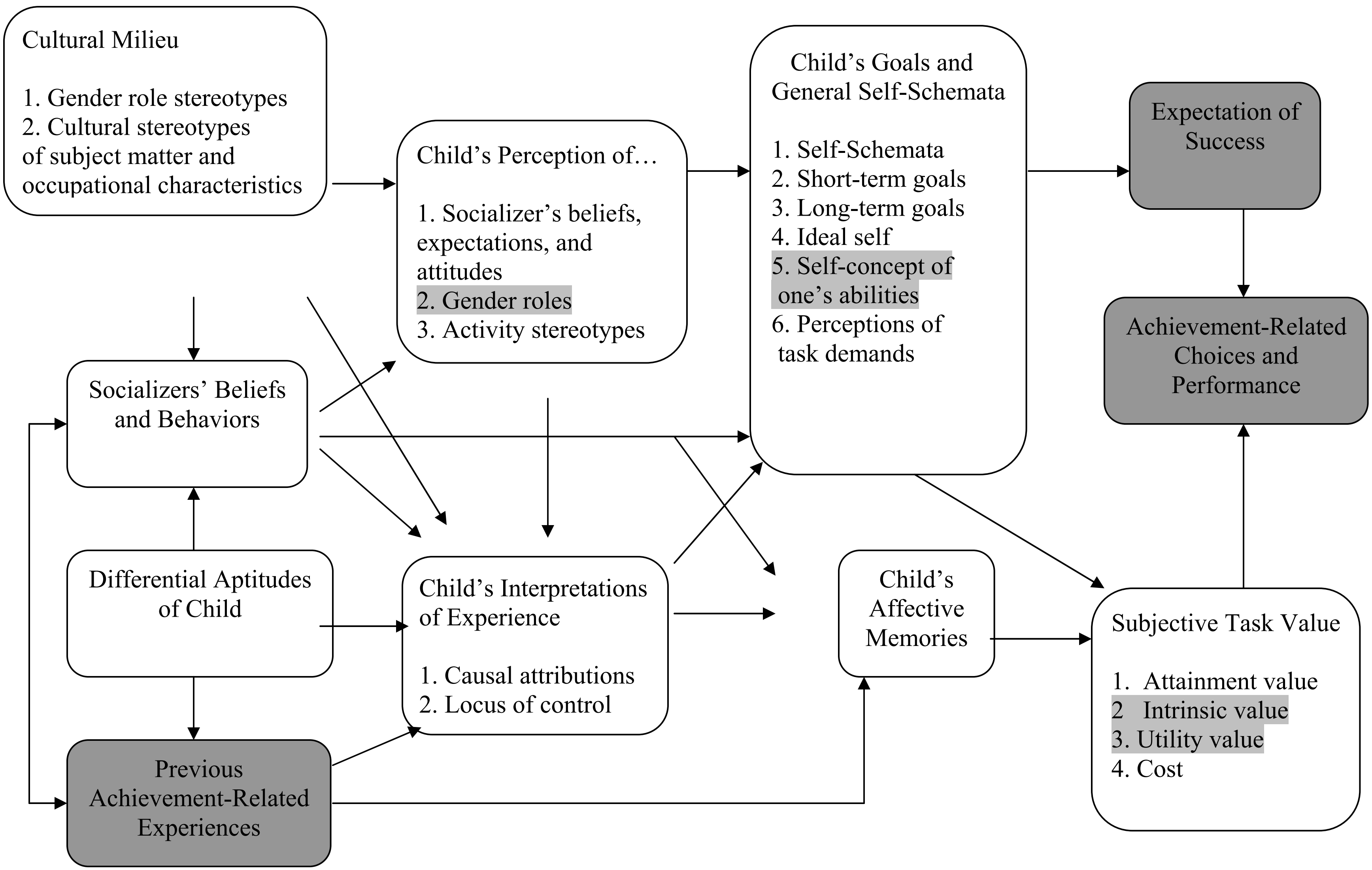


Figure 3. Relation between adolescents' computer attitudes, activities, and career beliefs: Moderated by sex

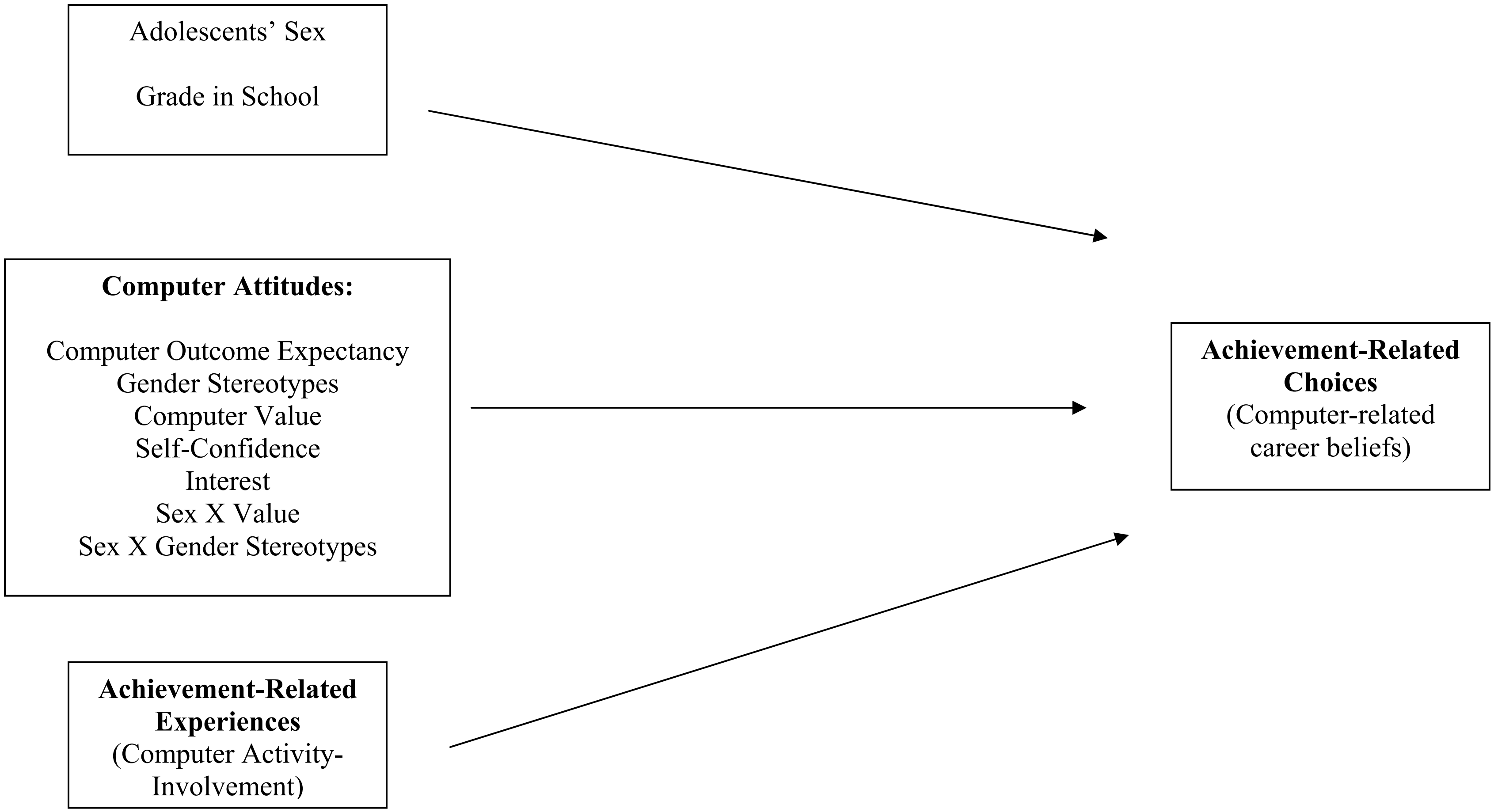


Figure 4. Overall Time on Computer at Home

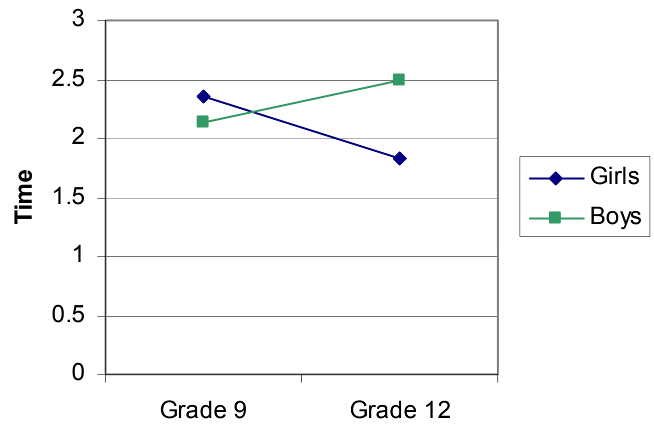


Figure 5. Time in Chatrooms/Instant Messaging

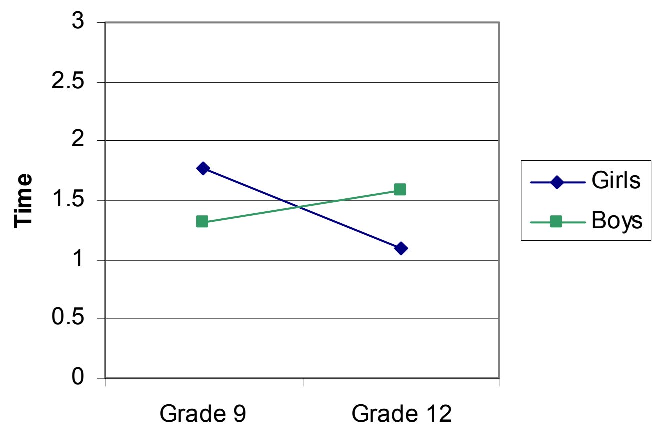


Figure 6. Number of Computer Courses

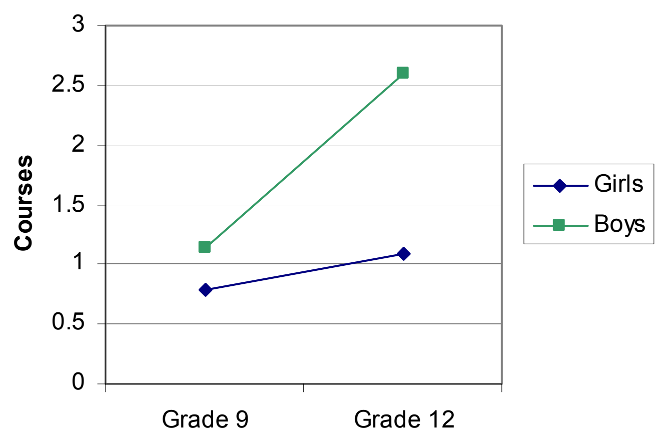


Figure 7. Computer Self-Confidence

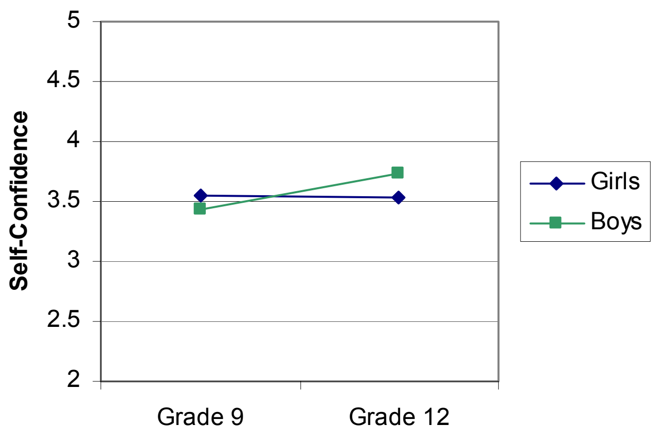


Figure 8. Enjoyment

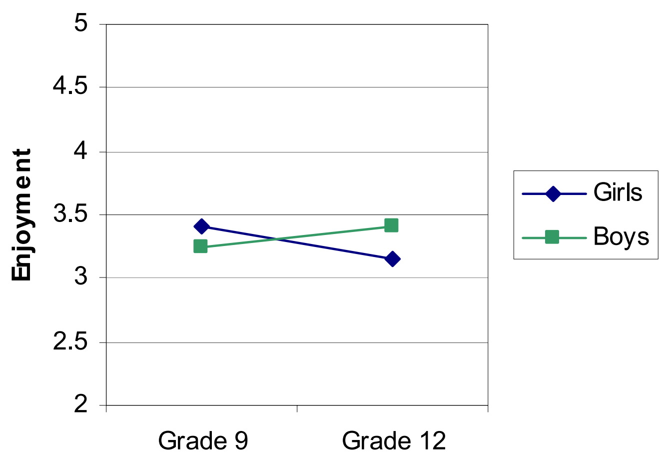


Figure 9. Preferences

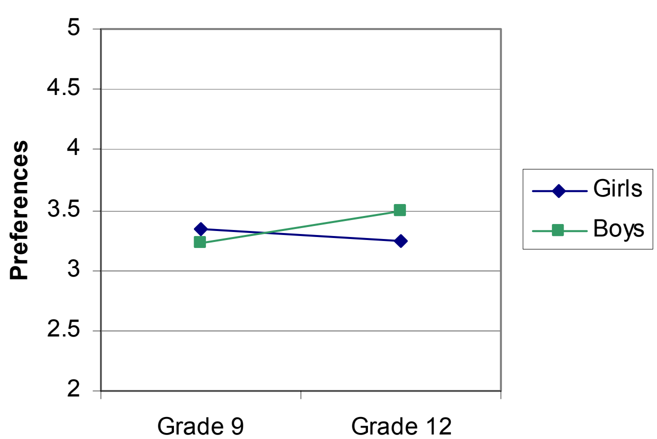


Figure 10. Communication

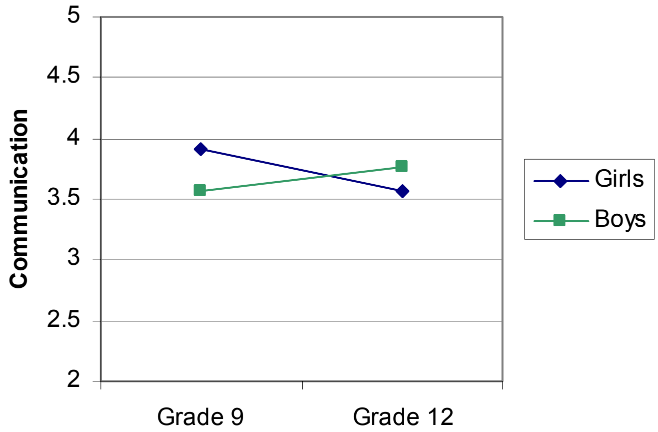


Figure 11. Give Help

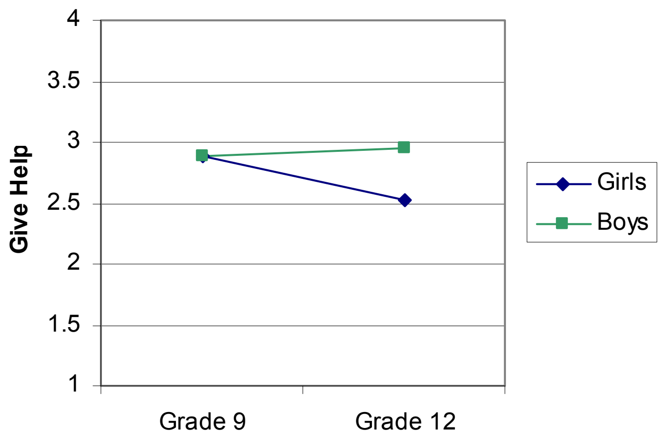


Figure 12. Need Help

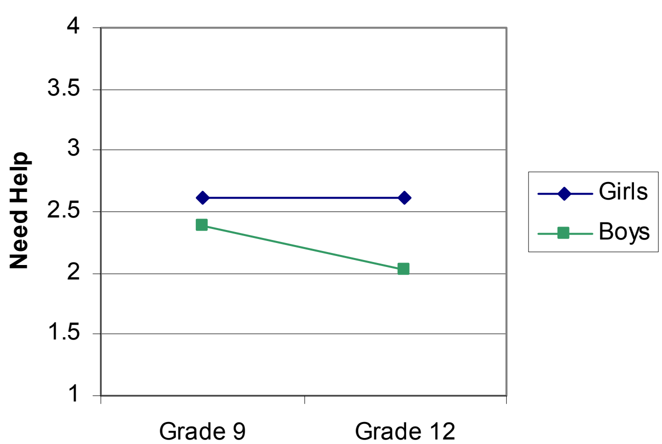


Figure 13. Computer Teacher Efficacy

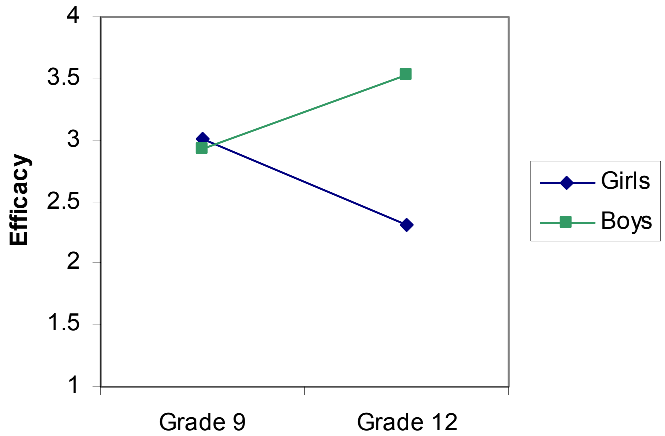


Figure 14.

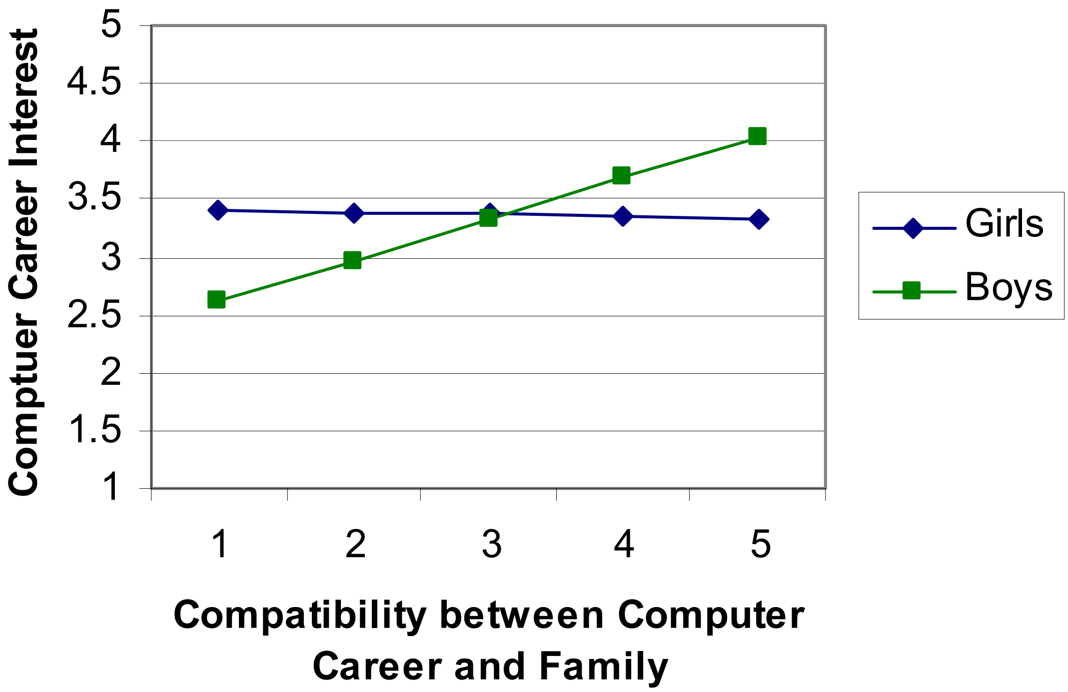
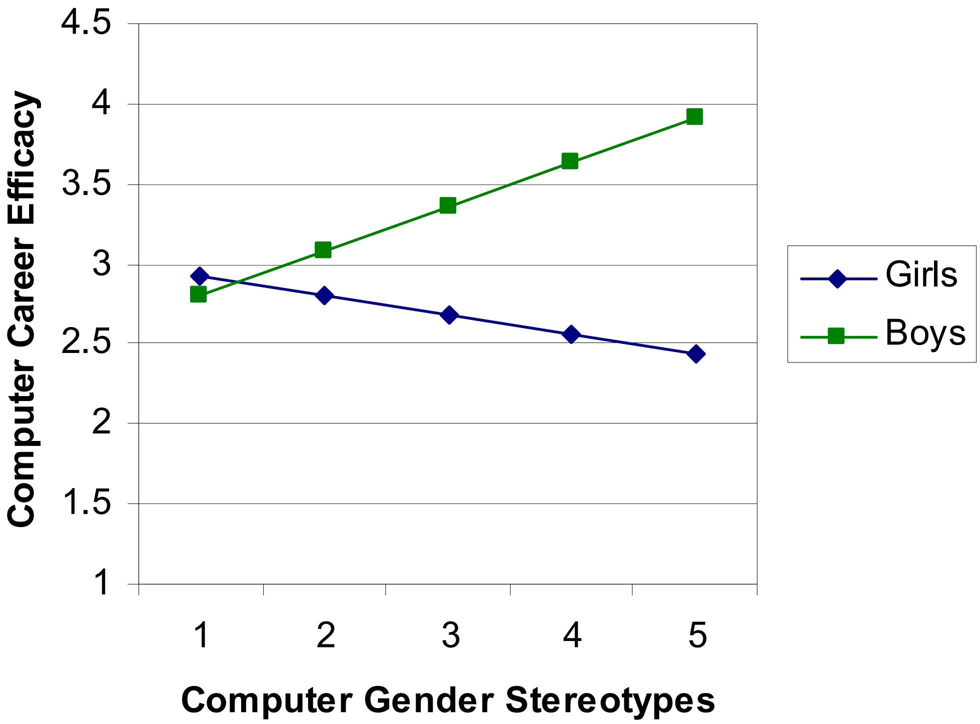

Comptuer Career Interest
5
4.5
4
3.5
3
2.5
2
1.5
1
1
2
3
4
5
Compatibility between Computer Career and Family
Girls
Boys

Figure 15


4.5
4
3.5
3
2.5
2
1.5
1
Computer Career Efficacy
1
2
3
4
5
Computer Gender Stereotypes
Girls
Boys

Appendix B: Descriptions of IT Careers Included in Web-based Survey

Computer scientist. People in this occupation work as theorists, researchers, or inventors. They have high levels of theoretical expertise, solve complex problems, and create new technology. They often develop and design specialized computer languages, programming tools, knowledge-based systems, and computer games.

Computer systems analyst. People in this occupation solve computer problems and use computer technology to help businesses or organizations.

Webmaster. These people are responsible for all technical aspects of a website, including performance issues such as speed of access. They also approve and edit the material included on websites.

Web developer/designer. People in this occupation are responsible for day-to-day website design and creation. Art or graphic design skills are desirable for Web developers.

Database administrators. People in this job set up computer databases, organize and store data and help people with their computer needs and questions.

Computer Support Services. These people deliver customer service and help people with their computer needs and concerns. They possess strong interpersonal skills and a basic understanding of how computers operate.

Computer Teacher. These people teach computer and technology classes at an elementary school or high school. They help students with computer needs and questions.

Appendix C: Computer Expertise, Factor Analysis

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	8.886	37.026	37.026	8.378	34.908	34.908	6.153
2	1.871	7.795	44.821	1.403	5.847	40.756	7.203
3	1.684	7.015	51.837	1.149	4.789	45.545	5.571
4	1.076	4.482	56.319	.583	2.430	47.975	4.304
5	.956	3.983	60.302				
6	.856	3.566	63.868				
7	.814	3.391	67.259				
8	.735	3.062	70.320				
9	.691	2.880	73.200				
10	.619	2.580	75.780				
11	.580	2.416	78.196				
12	.552	2.302	80.498				
13	.535	2.229	82.726				
14	.492	2.049	84.776				
15	.475	1.977	86.753				
16	.437	1.823	88.575				
17	.413	1.721	90.296				
18	.409	1.703	91.999				
19	.363	1.512	93.511				
20	.355	1.478	94.989				
21	.341	1.419	96.409				
22	.324	1.351	97.759				
23	.277	1.153	98.912				
24	.261	1.088	100.000				

Extraction Method: Maximum Likelihood.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Goodness-of-fit Test

Chi-Square	df	Sig.
393.651	186	.000

Factor Correlation Matrix

Factor	1	2	3	4
1	1.000	.671	.475	.403
2	.671	1.000	.680	.524
3	.475	.680	1.000	.381
4	.403	.524	.381	1.000

Extraction Method: Maximum Likelihood.
Rotation Method: Promax with Kaiser Normalization.

Structure Matrix
Extraction Method: Maximum Likelihood. Rotation Method: Promax with Kaiser Normalization.
Rotation converged in 6 iterations.

	Factor			
	1	2	3	4
Preferences				
I spend time configuring the computer to look and act as I want it to	.648	.519	.383	.303
I like to personalize my computer preferences	.787	.392	.299	.241
When I use new computer software, I like to change the preferences	.750	.530	.345	.375
I often customize the templates provided on computer software.	.585	.550	.430	.171
I can easily change the display properties on a computer.	.698	.484	.277	.492
I develop shortcuts and more efficient ways to use computers.	.671	.551	.382	.445
I learn new computer tasks by trial and error.	.515	.406	.234	.220
Troubleshoot				
I enjoy computer programming.	.484	.679	.649	.331
I like to figure out why computer errors occur.	.432	.676	.600	.321
If someone asked me how much RAM my computer had, I would know…	.496	.671	.462	.500
I am always up-to-date on current virus protection.	.359	.560	.369	.333
I understand how to network multiple computers.	.430	.733	.419	.472
I would rather fix a computer problem myself than have someone else help me	.531	.734	.501	.579
It's important to understand computers from the inside out.	.346	.432	.314	.098
Give Help				
Figuring out computer problems does not appeal to me.	-.333	-.513	-.742	-.390
I feel important when others ask me for information about computers.	.544	.479	.555	.163
Other students look to me for help when using the computer.	.511	.657	.551	.327
I help my friends when they have problems with computers.	.514	.606	.568	.337
Helping people with computer problems does not appeal to me.	-.271	-.476	-.794	-.398
I like to assist others on the computer.	.461	.616	.694	.273
Need Help				
I usually ask someone else to install new computer software for me.	-.347	-.454	-.353	-.702
When a computer freezes, I just ask someone else to deal with it.	-.301	-.405	-.297	-.683
If I wanted to burn a music CD, I would have to ask someone for help.	-.333	-.331	-.246	-.605
When I have trouble figuring something out on the computer, I give up easily.	-.288	-.416	-.474	-.629

Appendix D: Computer Value, Factor Analysis

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.608	32.988	32.988	5.069	29.815	29.815	4.299
2	2.023	11.899	44.887	1.626	9.566	39.381	3.439
3	1.737	10.218	55.105	1.303	7.666	47.047	3.356
4	1.322	7.776	62.881	.923	5.429	52.476	2.126
5	.842	4.952	67.833				
6	.777	4.569	72.402				
7	.700	4.117	76.519				
8	.605	3.558	80.078				
9	.571	3.356	83.434				
10	.489	2.878	86.313				
11	.482	2.837	89.150				
12	.467	2.747	91.897				
13	.356	2.092	93.989				
14	.300	1.764	95.752				
15	.273	1.605	97.357				
16	.250	1.470	98.827				
17	.199	1.173	100.000				

Extraction Method: Maximum Likelihood.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Goodness-of-fit Test

Chi-Square	df	Sig.
177.838	74	.000

Factor Correlation Matrix

Factor	1	2	3	4
1	1.000	.476	.552	-.232
2	.476	1.000	.287	-.352
3	.552	.287	1.000	-.257
4	-.232	-.352	-.257	1.000

Extraction Method: Maximum Likelihood.
Rotation Method: Promax with Kaiser Normalization.

Structure Matrix
Extraction Method: Maximum Likelihood. Rotation Method: Promax with Kaiser Normalization.
Rotation converged in 6 iterations.

	Factor			
	1	2	3	4
Computer as a tool				
Computers can allow me to do more interesting and imaginative work.	.754	.461	.329	-.159
Computers can enhance the presentation of my work	.838	.365	.451	-.257
Computers help me organize my work better.	.790	.411	.481	-.224
I use a computer to save time on work that would take longer otherwise.	.759	.328	.524	-.164
Computers are a tool to be used to get other things done.	.523	.199	.261	-.027
Computer Affect				
I am interested in finding out about new computer products I can use…	.437	.602	.209	-.241
I feel happy when walking into a room filled with computers.	.361	.573	.308	-.172
Computers are interesting in and of themselves.	.498	.522	.284	-.180
It is fun figuring out how computers work.	.355	.833	.225	-.329
Learning about the different uses of computers is interesting	.319	.820	.194	-.289
Communication				
I value the ability to communicate with friends via the computer.	.529	.243	.912	-.228
I only use the Internet when I have to.	-.286	-.191	-.602	.143
I like the way the Internet keeps me in touch with other people.	.517	.244	.847	-.243
Computers can be used for the benefit of solving social problems	.241	.309	.383	-.169
Geeks Gadgets and Greed				
The only people who go into computer science are geeks.	-.155	-.244	-.117	.763
People who like computer science are only interested in gadgets.	-.155	-.220	-.216	.745
People in computer science are only out to make a lot of money.	-.151	-.300	-.213	.588

Vita

Martha M. Bleeker

EDUCATION

2001 – Present	Pennsylvania State University PhD in Human Development and Family Studies, Minor in Statistics August 2005
1999 – 2001	Pennsylvania State University Master of Science in Human Development and Family Studies December 2001 Master's Thesis: The Long-term Implications of Mothers' Expectations: Effects of Parental Gender-Stereotypic Beliefs on Mathematics and Science Achievement from Early to Late Adolescence
1995 – 1999	Emporia State University Bachelor of Science in Psychology, Summa Cum Laude Minor in Ethnic & Gender Studies May 1999

SELECTED PUBLICATIONS

Bleeker, M. M. & Jacobs, J. E. (2004). Achievement in math and science: Do mothers' beliefs matter twelve years later? *Journal of Educational Psychology, 96(1),* 97-109.

Jacobs, J. E. & Bleeker, M. M. (2004). Girls' and boys' developing interests in math and science: Do parents matter? In Bouchey, H. A., & Winston, C. E. (Eds.), *New Directions for Child and Adolescent Development: Social and Self Processes Underlying Math and Science Achievement*, (Vol. 106, pp. 5-21). San Francisco: Jossey-Bass.

Jacobs, J. E., Bleeker, M. M., & Constantino, M. J, (2003). The self-system during childhood and adolescence: Development, influences, and implications. *Journal of Psychotherapy Integration, 13(1),* 33-65.

Jacobs, J. E., Davis-Kean, P., Bleeker, M. M., Eccles, J. S., & Malanchuck, O. (2005) "I can, but I don't want to": The impact of parents, interests, and activities on gender differences in math.. In A. Gallagher and J. Kaufman (Eds.), *Gender Differences in Mathematics: An Integrative Psychological Approach,* (pp. 246-263). New York: Cambridge University Press.

SELECTED PRESENTATIONS

Bleeker, M. M. (2002, April). Parents' influence on the math and science career plans of adolescents. Poster presented at the Biennial Meeting of The Society for Research on Adolescence, New Orleans, LA.

Bleeker, M. M. (2003, April). Children's attraction to math and science: The importance of parents' gender stereotypes and activities. Paper presented at the Biennial Meeting of The Society for Research on Child Development, Tampa, FL.

Bleeker, M. M. (2004, March). Relations between parents' behaviors and adolescents' math values: Patterns of behavior within the family. Poster presented at the Biennial Meeting of The Society for Research on Adolescence, Baltimore, MD.

Bleeker, M. M. (2005, June). Examination of U.S. adolescents' computer activities, attitudes, and career plans. Invited paper to be presented at Women, Work and IT Forum, Brisbane, Australia.

Bleeker, M. M., & Chhin, C. S. (2004, April). Adolescents' gender beliefs and career efficacy: Does family income matter? Poster presented at the Gender Development Conference, San Francisco, CA.

Bleeker, M. M., Ferrer-Wreder, L., Small, M., & Domitrovich, C. (2005, April). Predictors of academic responsibility among urban, African-American students: Does gender matter? Poster presented at the Biennial Meeting of The Society for Research on Child Development, Atlanta, GA.

Chhin, C. S., Bleeker, M. M., & Jacobs, J. E. (2005, April). Longitudinal relations between parents' and children's gender role attitudes and their sex-typed occupations. Poster presented at the Biennial Meeting of The Society for Research on Child Development, Atlanta, GA.