Chapter II
Exploring Gender Differences in Computer-Related Behaviour:
Past, Present, and Future

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ABSTRACT

This chapter explores gender differences in three key areas: computer attitude, ability, and use. Past research (10-25 years ago) is examined in order to provide a framework for a more current analysis. Seventy-one studies and 644 specific measures are analysed with respect to overall patterns, time, education level, and context. Males and females are more similar than different on all constructs assessed, for most grade levels and contexts. However, males report moderately more positive affective attitudes, higher self-efficacy, and more frequent use. Females are slightly more positive about online learning and appear to perform somewhat better on computer-related tasks. The results must be interpreted with caution because of methodological limitations in many studies reviewed. Finally, a model is proposed to understand and address gender differences in computer-related behaviour.

INTRODUCTION

A reasonable argument could be made that computers are integrated into every major area of our lives: art, education, entertainment, business, communication, culture, media, medicine, and transportation. It is equally reasonable to assume that considerable power and success rests with understanding how to use this technology meaningfully and effectively. Many children start interacting with computers at three to four years of age, however, gender-based socialization begins much earlier when someone asks, "Is it a boy or a girl?" (Paoletti, 1997). A critical question arises as to whether computer behaviour is influenced by gender. Given the prominent role that computers play in our society, it is vital that males and females have equal opportunity to work with and benefit from this technology.

Numerous studies have investigated the role of gender in computer behaviour over the past 20 years (see AAUW, 2000; Barker & Aspray, 2006; Kay, 1992; Sanders, 2006; Whitley, 1997 for detailed reviews of the literature) and the following conclusions can be made. First, most studies have looked at computer attitude, ability, and use constructs. Second, clear, reliable, valid definitions of these constructs are the exception, rather than the rule. Third, roughly 30% to 50% of the studies report differences in favour of males, 10% to15% in favour of females, and 40% to 60% no difference. Fourth, differences reported, while statistically significant, are small. Overall, one could say there is a persistent pattern of small differences in computer attitude, ability, and use that favours males; however, considerable variability exists and has yet to be explained.

There are four main objectives for this chapter. First, past research on computers and gender will be summarized by examining the results of five previous literature reviews. Second, a more current analysis of gender and technology will be provided by looking at a comprehensive set of studies done over the past 10 years. Technology changes quickly, so might the attitudes and abilities of people who use this technology. Third, a clear emphasis will be placed on examining the impact of contextual issues (e.g., type of technology used, age group, setting, culture) in order to explain some of the variability observed in past research. Finally, a model for understanding gender differences in computer behaviour will be proposed to help set an agenda for future research.

BACKGROUND

At least five comprehensive reviews have been done examining various aspects of gender and the use of computers (AAUW, 2000; Barker & Aspray, 2006; Kay, 1992; Sanders, 2006; Whitley, 1997). Each review is well worth reading and offers detailed, insightful information about gender and technology. I offer a brief synopsis of key insights these authors make that help frame the ideas presented in this chapter.

Whitley Review

In 1997, Whitley did a metaanalysis involving 82 studies and 40,491 American and Canadian respondents from 1973 to 1993. Regarding computer attitudes, it was found males had more positive affective attitudes toward computers. Mean effect sizes ranged from .08 for grammar school students, .22 to .24 for college students and adults, and .61 for high school students. Note that Cohen (1988, 1992) suggests that an effect size of .10 is small, .30 is medium, and .50 is large. This means that gender did play a moderate to significant role with respect to liking computers in the early period of computer use in North America.

General cognitive attitudes or beliefs about computers appeared to show little gender bias, with effect size ranging from .04 (college students) to .20 (grammar school). However, when focusing on computer-based stereotypes or sex biases, males were substantially more biased in their attitudes with effect size ranging from .44 (college students) to .67 (grammar students).

Self-efficacy toward computers followed a similar pattern to affective attitudes. Effect size was not substantial for grammar school students, but favoured males in high school and beyond (r=.32 to .66). Even though males reported more confidence in using computers, effect size for computer experience was relatively small (r=.15 to .23). Finally, it appears that males used computers more often than females for all ages groups (r=.24 to .40), although this effect size range would be considered moderate according to Cohen (1998, 1992).

In summary, Whitley offers a statistical snapshot of male-female differences in computer attitude, ability, and use for North Americans prior to 1993.

Sanders Review

Sanders (2006) took a markedly different approach to reviewing the literature on gender and technology. Over 200 articles were examined, covering an approximate time period from 1990 to 2001, but the goal was to offer possible explanations for why women were so under represented in the field of Computer Science. The review, while not statistically rigorous, offers a multicultural, rich perspective on the potential factors that contribute to gender biases in computer-based behavior.

Sanders discusses in some detail the influence of society (e.g., parents, media, SES), age, attitude, ability, use patterns, and the classroom. Regarding attitude, ability, self-efficacy, and use, her results are consistent with Whitley. In addition, she offers the following observations:

- Stereotypes can start with parents
- The media portrays computers as a male domain
- High SES is associated with greater promotion of computers in girls
- Stereotyped use of computers starts at preschool
- Gender differences tend to increase with age
- Males enroll in more computer-based courses
- Males play more computer games
- Differences between males and females in the area of online learning are not as prominent as in other areas
- The computer curriculum in high school favours male interests

This review generated some very interesting and provocative reasons for why males are far more actively involved in the field of Computer Science. Perhaps the most profound statement that Sanders made was that even with sizeable gender differences observed in attitude, ability, and use, almost no effort was being made to investigate possible interventions that could level the proverbial "computer" playing field.

Barker and Aspray Review

Barker and Aspray (2006) provide a methodical and detailed analysis of research on girls and computers. Their approach is similar to that of Sanders (2006) in that they offer a rich discussion on factors that inhibit girls from pursuing careers in information technology. Their findings on computer attitude and use, dating from 1992 to 2004, are aligned with those reported by Whitley (1997) and Sanders (2006). They deliberately chose not to look at differences between girls and boys in computer literacy or ability.

A number of noteworthy observations were articulated in this review. First, elementary teachers, who are primarily females, have limited computing skills and therefore act as poor role models for young girls. Second, the gender gap with respect to computer access and use has narrowed rapidly over the past 5 years. Third, boys still use computers more than girls at home, although each sex uses computers for different reasons. Boys use games, educational software, and the Internet more, whereas girls use computers for e-mail and homework. Finally, the culture of computing is largely driven by males, and females begin to reject this culture starting in early adolescence. Females favour careers in more socially oriented fields such as medicine, law, or business and see computer-based occupations as boring and menial. Ultimately, it may do little good to give females extra resources designed to increase expertise in computers, when they find the IT curriculum to be "out of touch" with their experiences and interests.

American Association of University Women (AAUW), 2000

The AAUW (2000) did an extensive review of the research on gender and technology with the primary goal of identifying changes needed in the current computer culture to make it more appealing to girls and women. They agree with Barker and Aspray (2006) that girls reject the violence and tedium of computer games and would prefer to use technology in a meaningful manner. They summarize this position by stating that many girls have a "we can, but don't want to" attitude about technology.

The AAUW (2000) offers a poignant explanation of why a commitment to lifelong technology learning is important. They note that being successful in working with technology involves the ability to adapt to rapid changes, to critically interpret the morass of electronic information available, and to experiment without fear.

Kay Review

In 1992, Kay summarized the results of 98 articles looking at gender and computer attitude, ability, and use. The familiar pattern of male prevalence in these areas was observed. Of course, these results are dated now, but the final conclusion of this study is still valid. In the vast majority of studies analyzed in the past, clear, reliable, valid, and consistent measures of attitude, ability, and use constructs are rarely offered. Unfortunately, measurement problems are still substantial. Out of 644 measures used to analyze gender differences in this chapter, 24% offered estimates of reliability and 18% examined validity. The uncertainty and lack of cohesion with respect to constructs used to establish gender differences undermines the process of understanding and addressing gender differences and technology.

In general, when asked which sex is more positive toward computers, more apt at using computers and more likely to use a computer, one would best be advised to answer, 'It depends.' It depends on what attitudes you are measuring, what skills you are assessing and what the computer is being used for. (Kay, 1992, p. 278)

Objectives of this Chapter

The goal of this chapter is to build on previous research in order to provide a current and cohesive perspective on gender and technology. This goal will be achieved by:

- Collecting the most recent empirical data available after Whitley's (1997) review
- Focusing on the broader intent of creating technologically thoughtful, effective, risk takers (AAUW,2000), as opposed to IT professionals (Barker & Aspray, 2006; Sanders. 2006;)
- Determining how current data support the richer, contextual patterns noted by Sanders (2006) and Barker & Aspray (2006)
- Proposing a model to explore gender differences
- Discussing how a coherent model might advance an intervention program that Sanders (2006) notes is clearly lacking
- Examining methods and strategies that can help improve the quality and impact of information that is needed to develop a more comprehensive understanding of gender and technology (Kay, 1992)

Note that the term computer and technology will be used interchangeably. I realize that "technology" has a broader focus, but with respect to research involving gender differences, the sole area investigated involves computers.

Data Analysis

Seventy-one refereed (see Appendix for full list) papers were reviewed for this chapter spanning a decade of research (1997-2007). Each paper was coded for measures of attitude, ability, self-efficacy, and use. Each of these constructs was divided into subcategories to illustrate the wide range of computer behaviours assessed. This process resulted in 644 tests of gender differences involving more than 380,000 people, from 17 different countries. Computer behaviour was looked at from four main settings: home, school, the workplace, and online communication. Eight distinct populations were examined including kindergarten, elementary school (Grade 1-5), middle school (Grade 6-8), high school (grade 9-12), undergraduates, preservice teachers, graduate students, and adults. Each of the 644 tests of gender difference was rated according to whether there was a significant male advantage, a significant female advantage, or no difference.

In summary, every attempt was made to flesh out as much context as possible with respect to results reported; however, speculation was kept to a minimum when there was not enough evidence to make a firm conclusion. It is also important to recognize that while an attempt will be made to find patterns in gender differences with respect to attitude, ability, and use, the analysis will be compromised by the multitude measures used to address these constructs and the limited reliability and valid statistics available.

CURRENT RESEARCH ON GENDER AND COMPUTERS (1997-2007)

Computer Attitudes: Affect and Cognition

Computer attitudes accounted for 31% (n=202) of all gender-technology comparisons assessed for this chapter. It is a daunting task, though, to sort out the numerous types of attitudes assessed. Two principle constructs, based on Ajzen and Fishbein's (1988) theory of attitude measurement, provide a schema for understanding the numerous attitude scales.

The first construct is based on affect and, to date, encompasses two basic emotions: anxiety and happiness. Samples of affective attitudes are computer anxiety, computer enjoyment, comfort level, software and activity preferences, liking, motivation, fun, and sense of achievement. The second construct looks at cognitions or a person's beliefs about computer-related activities and environments. Some examples of cognitive attitude are stereotyping, importance, perceived usefulness, trust, and acceptance.

When looking at studies measuring affective attitudes, males had more positive feelings 33% (n=30) of the time, females had more positive feelings 15% (n=14) of the time, and there were no differences 52% (n=64). There appears to be a moderate male bias with respect to affective attitude toward computers. The situation, though, is different for cognitive attitude where males had more positive thoughts about computers 23% (n=26) of the time, females more positive thoughts 20% (n=21) of the time, and no differences were reported 58% (n=64) of the time. Males and females do not appear to differ with respect to computer-based cognitions.

~~valence on affect than cognition.~~

Digging into the attitude data a little deeper reveals several patterns. First, there appears to be no obvious change in male-female differences in overall attitudes over the past 10 years. While there is some fluctuation in favour of males or females on a year-by-year basis, males are slightly more positive than females when it comes to feelings about computers. One might expect that as the technology becomes more accessible, easier to use, and more diverse in application, that computer attitudes might level out between the sexes. This appears not to be the case. In fact, the most recent studies (2005-2007) show a strong male bias for both affective and cognitive attitude (40% favour males, 15% favour females, 45% show no difference).

A second pattern looks at the relationship between grade and gender differences with respect to overall computer attitudes. In elementary school (grades 1-5), females appear to have slightly more positive attitudes about computers, although the number of tests was small (n=9). In middle school, females and males have similar attitudes toward computers, but in high school males show more positive attitudes, a bias that continues in university. Male and female preservice teachers and graduate students have similar attitudes toward computers, but the general adult population shows a strong male bias. This pattern is consistent with previous reviews of gender and technology. Males and females do not start out with different feelings and thoughts about computers, they emerge over time and seem to be influenced by education level and culture. Nonetheless, it is absolutely critical to keep these findings in perspective. Most females or males do not follow this pattern. Even in the most extreme case (high school), male bias means males had more positive attitudes in about 40% of all tests done. Another way of stating this result is that females have more positive attitudes or there is no difference in of 60% of the cases observed.

The third pattern observed with respect to male-female differences in attitude involves the setting or context where computers are used. Surprisingly, not one study out of the 71 reviewed for this chapter looked at attitude toward home use of computers. When looking at gender differences in school, males reported more favourable attitudes 46% of the time, females were more positive 16% of the time, and no difference in computer attitude at school was observed 38% of the time. However, when one shifts to an online context, the picture is decidedly different. In this context, females were more positive 21% of the time, no difference was observed 76% of the time, leaving males with having more favorable attitudes only 3% of the time. When context was not mentioned at all, gender differences in attitude were marginal (27% favour males, 18% favour females, 55% no difference).

This analysis of context tells us that setting is important when looking at attitude toward computers, although a finer granularity is needed in future research. It is concerning that males are more positive toward computers in a school setting, but it is unclear what they are positive about, games, educational software, presentations, word processing? Azjen and Fishbein (1988) note that the more specific one is about the object of an attitude, the higher the predictive value. On the other hand, it is encouraging that females respond equally if not more positively to an online environment. Again, it is important to investigate the explicit nature of these attitudes in order to understand dynamics of gender-technology interaction.

In summary, the current analysis of gender and attitude toward computers offers the following conclusions. First, computer attitudes appear to be biased in favour of males with respect to affect but not cognition. Second, this bias typically means that males are more positive 30% to 40% of the time, females are more positive 15% to 25% of the time, and there is no difference 45% to 55% of the time. Third, differences do not appear to be attenuating over time, but are influenced by education level and the setting in which computers are used. Finally, more precise definitions of attitude and context are needed in order to develop a more comprehensive understanding of gender differences in computer technology.

Computer Ability and Self-Efficacy

I have put computer ability and self-efficacy in the same section because gender-computer researchers have not been precise when defining these terms. The rating of one's actual computer ability and one's confidence or belief in being able to perform a computer-related task (computer-self-efficacy) is often blurred. I will discuss each construct independently, but until operational definitions, reliability, and validity are reported more regularly, a sizeable overlap may exist between the two.

Ability

Differences between males and females regarding computer ability were looked at 93 times (14% of the total sample). Definitions of ability included general knowledge, games, application software, online tools, programming, and performance. Overall, males rated themselves higher in computer ability 47% of the time, females rated themselves higher just 9% of the time, and both sexes reported equal ability 44% of the time. This difference between males and females is accentuated if one removes actual performance estimates of ability. When looking at self-report measures, males rate themselves as having higher ability 60% of the time. However, if one looks at performance measures alone, females exceed males in computer ability. Five percent of the time males are better, 24% of time females are better, and 71% of the time there is no difference. Males have decidedly greater ability than females when self-report measures are used, but when actual performance is assessed, females appear to have the advantage. This anomaly calls into question the reliability and validity of using the self-report technique. More work needs to be done validating the accuracy of assessment tools used to evaluate computer ability.

It appears that estimates of computer ability from 1997 to 2007 are fairly stable (45% favour males, 10% favour females, 45% show no difference). One might expect that previously reported differences in favour of males would lessen over time given the increased ease of using a computer, but this expectation is not supported. On the other hand, the stability may simply mean that males continue to have inflated ratings of their computer ability.

It is particularly informative to look at computer ability across grade levels. Computer ability is essentially equal for all grade levels except university students and general working professionals, where males show significantly higher levels. It is unclear what happens at university or in the workplace that might cause this difference. What is clear is that most of the research on gender disparities in computer ability has focused on subjects who are 18 years or older. Without a broader representation of the total population, it is challenging to give a more informed analysis with respect to the impact of gender on computer ability.

Self-Efficacy

Only 6% (n=38) of the gender tests focused on self-efficacy; therefore, a detailed analysis of this construct is not possible, nor reliable. Not surprisingly, the overall pattern for computer self-efficacy is almost the same as that for self-report measures of computer ability. Fifty-three percent of males felt more confident than females; the reverse scenario was observed only 5% of the time. Forty-percent of the time, males and females reported equal self-efficacy. As stated earlier, because of limitations in research methodology, self-rating of computer ability may be synonymous with self-efficacy. That said, one should not underestimate the influence of self-efficacy. It is entirely reasonable that feelings of confidence can influence computer behaviour and use. Even though there is evidence to suggest that females are as good if not better at using computers, self-efficacy could be holding them back. The relationship among self-efficacy and actual computer use has not been examined in detail; however, it should be placed on future research agendas.

Computer Use: Frequency

One could argue convincingly that the ultimate goal of understanding and addressing gender differences in computer–related behaviour is to ensure that males and females have the same choices and opportunities to use computers. This section will look at both frequency of use and actual computer behaviours.

Twenty-seven percent (n=172) of tests analysed for this chapter looked at computer use. This construct covered a number of domains: general use, access to computers, application software, entertainment, programming, and the Internet. Regardless of the domain, males used computers more often than females 40% of the time, females used computers more than males 5% of the time, and no difference in use was reported 56% of the time. Use of application software (74% no difference) and having access to computers (67% no difference) were the least gender-biased activities, whereas using the computer for entertainment (31% no difference) and general activities (43% no difference) were the most gender biased. Identifying the precise area of use, then, is important. Using computers for games, for example, may be an activity that is dominated by males, but participation will not necessarily be advantageous with respect to learning new software or making informed choices using technology. On the other hand, if females had significantly less access to a computer, which does not seem to be the case, that would be cause for concern because both opportunity and choice would be restricted.

An encouraging pattern with respect to use is the trend of decreased gender bias in computer use over the past 10 years. From 1997 to 2000, males reported using computers more than females 62% of the time. This decreased to 37% from 2001 to 2004 and 29% from 2005 to 2007. With respect to context, general (51% males report more use) and home (55% males report more use) use indicated significant male advantages, although no differences were observed at school or online. Interestingly, gender bias with respect to home and general use appears to be decreasing over time. Use in these two settings was strongly sex biased with 86% of males reporting significantly more use from 1997 to 2000, but from 2005 to 2007, male dominance dropped to 45%.

A closer look at the school context reveals that while no differences between males and females exist for elementary school students with respect to computer use, this pattern changes abruptly for all other education levels including middle school and university (38% male dominance), high school (51% male dominance), and the workplace/general population (60% male dominance). If one takes into account time and education level, high school and university male students continue to exceed their female counterparts (between 33% and 44%), but not at the same level as previous years. Middle school use of computers, unfortunately, has not been studied in the past 3 years with respect to gender.

The results regarding computer use and gender difference offer a somewhat complicated picture. Clear gender differences in that appeared between the years of 1997 to 2000, attenuated markedly from 2005 to 2007. Areas of concern still exist for home and general use as well as high school and university settings, but even for these hotspots, a decreasing gender gap is a promising trend.

Actual Behavior

Actual computer behaviour has been studied far less than frequency of computer use, yet it is specific behaviour that can help uncover clues and nuances with respect to gender differences. While 14% (n=89) of the total sample of tests forged into an analysis of how males and females behave while using computers, only 6% (n=37) presented formal comparisons. No fewer than eight categories of behaviour were identified including cognitive activities, collaboration, communication, learning, teaching, problem solving, use of software help, and same vs. mixed-sex behaviour. Overall, no significant differences were reported with respect to specific computer behaviours 76% of the time. This does not mean that males and females do not behave differently with respect to computers, because the vast majority of studies on computer behaviour are qualitative and present rich descriptions of highly contextualized situations.

There are some interesting and potentially informative observations made with respect to actual behaviour. For example, in an online environment there is some evidence to suggest males are more authoritative and assertive (Fitzpatrick & Hardman, 2000; Guiller & Durndell, 2006) in online discussions, but are more flexible in a face-to-face conversation. Females, on the other hand, change their opinions more in an online than face-to-face environment. Another study indicated that girls accounted for nearly twice the number computer-based interactive behaviours than boys did (e.g., helping another student, asking questions) in an elementary school class (Waite, Wheeler, & Bromfield, 2007). Some researchers have examined the dynamics that occur in same vs. mixed-sex groups. Both males and females appear to do better with their same sex peers (Fitzpatrick & Hardman, 2000; Jenson, deCastell, & Bryson, 2004; Light, Littleton, Bale, Joiner, & Messer, 2000). Finally, some boys may not take girls seriously in terms of computer knowledge. Jenson et al. (2003) reported that even when girls were trained and had superior knowledge, boys tended to rebuff their attempts to help and guide.

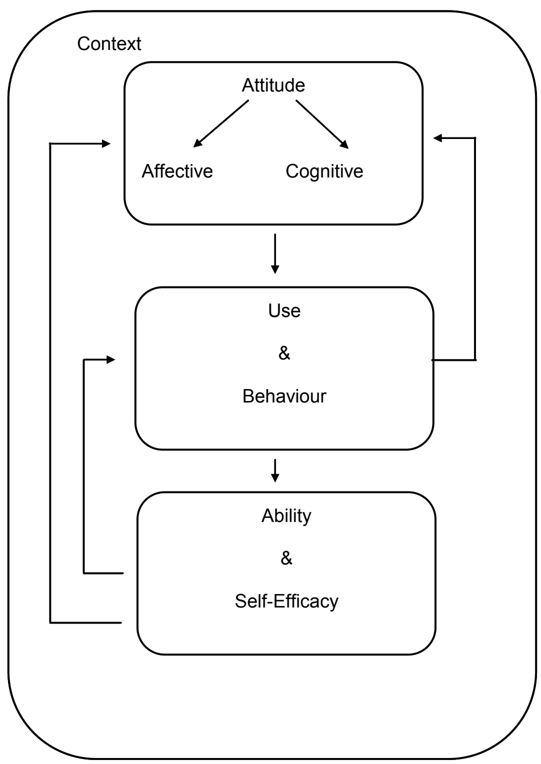
These computer behaviour results have to be interpreted cautiously, as they are often detailed, but isolated examples collected from small samples. However, the kind of insight provided by rich qualitative investigation is critical to develop an effective, workable model to explain the interaction between gender and technology. We want males and females to have choice in using computers, but we do not want to undermine the learning process, for example, where it may be the case each sex reacts differently to online discussions. We certainly want to create an atmosphere of mutual respect and support in a computer-based classroom, although, there is some evidence to suggest that effective knowledge building may be undermined by gender prejudice. In short, while it is important to examine computer attitude, ability, self efficacy, and use, it is challenging to build a cohesive and informative model of gender and technology using only survey methodology.

FUTURE TRENDS AND RESEARCH DIRECTIONS

It is clear that more effort needs to be directed toward developing a model for interpreting and addressing gender differences in computer-related behaviour. Isolated studies in this area have taken place for over 30 years. Solid reviews of the literature are helpful, but there is an overwhelming need to organize this data into a more coherent whole. I propose the model in Figure 1 to help organize and understand future research. The model is not empirically supported, but takes into account the full range offactors that have been studied to date.

The model is premised on the following assumptions. First, the major components, computer-based attitudes, ability, self-efficacy, use, and behaviour, occur in a context. The context may be an elementary or high school classroom, a business, an online discussion board. This means there could be slightly or drastically different dynamics in different environments. The more that one describes a given context, the more

Figure 1. A model for understanding gender and computer-related behaviour



effective the model will be in predicting and understanding behaviour. Second, attitude needs to be divided into at least two main constructs: affect and cognition. This division has been shown to be meaningful in the present analysis. It is speculated that attitudes, depending on whether they are positive or negative, lead to acceptance, neutrality, or rejection of computers. This, in turn, will prompt an individual to avoid or learn more about computers. If the context permits adequate access to computers, then a user can begin to develop computer ability and self-efficacy. Once a person begins using a computer, the type of use and specific behaviours experienced will have a direct effect on attitude. If a person experiences successful use of computers he/she will use a computer more, develop more positive affect and cognitions, and increased skills. If a person experiences challenges and significant barriers, attitude may become increasingly negative to the point of non-use. This model offers opportunities for future research with respect to improving methodology, addressing context, shifting focus, and developing intervention strategies. Each of these will be discussed in more detail.

Improving Methodology

What is blatantly clear is that researchers need to be more precise in operationally defining their constructs, and providing estimates of validity and reliability. A considerable leap of faith was taken, perhaps recklessly, in analyzing and reporting gender and technology research for this study. Only 17 out of the 71 studies discussed validity and offered reliability estimates of .70 or better. This accounted for only 9% (n=64) of all the data. In 1992, (Kay, 1992) I made the exact same plea to improve the quality of research simply because it is difficult to be confident in the results reported. While most research methodology is flawed in some way, developing solid assessment tools is fundamental to advance our knowledge on gender and technology.

Another suggestion, partially based on the next section on context, is to make scales domain specific. General measures give us watered-down estimates of attitude, ability, self-efficacy, and use. The results of the current review suggest that context is very important. For example, it was reported that males have more positive affective attitude toward computers. A closer look over a broad range of studies reveals that males may be very positive about using computers for entertainment, whereas females seem to prefer e-mail and using computers for a meaningful task. A general measure of computer affect would not uncover these important differences.

One final idea is to study multiple constructs simultaneously. Many studies focus on one or two areas of interest, but the ideal study should examine all of the key areas: attitude, ability, self-efficacy, and use. This way a statistical analysis can be done to examine the relationships among constructs. This kind of analysis is critical for model building.

Addressing Context

Models for understanding gender and technology need to start from a specific context. There is growing evidence, for example, that females are responding very positively to online environments, sometimes more positively than males. In high school and university settings, males continue to display more favourable computer attitudes, ability, and use. Sanders (2006) and Barker and Aspray (2006) speculate as to why these differences emerge, but more systematic research and evidence is needed to discover the mechanisms of bias. Detailed research looking at a wide range of behaviours over an extended time period will help reveal contextual complexities.

Shifting the Focus

The current research menu for investigating gender differences and technology over past decades needs to be altered in at least four fundamental areas. First, more effort needs to be directed toward understanding computer ability. Self-report measures do not align well with actual performance on computers. More effort needs to be directed to distinguishing self-efficacy from ability and gathering data that represents an accurate estimate of skill.

Second, researchers need to actively collect data from younger populations. Most of the current data is based on university students and the general population, age 18 years or older. This approach may promote the reporting of gender biases, simply because the subjects involved are older and may not be reflective of the current computer culture. Computer use for elementary school students today is far different than it was for university students 10 to 15 years ago. To get the most current snapshot of potential gender disparities, students from K to 8 need to have a stronger presence. Trends of computer use reflecting a reduced gender gap support the need for this shift.

Third, a research program focusing on gender and technology with respect to preservice and experienced teachers needs to be developed. Only 3 out of the 71 studies analysed for this chapter looked at the preservice population and no studies examined in-service teachers. Educators, though, are probably a primary influence, both indirect and direct, on students' behaviours toward computers. If a single teacher has a negative attitude toward computer use and is unable or unwilling to integrate computers in the curriculum, it can affect numerous students over an extended time period.

Finally, there is a clear need for richer, qualitative research all on key areas of computer behaviour. Qualitative research accounted for just 2% of the data points collected in this chapter (Goldstein & Puntambekar, 2004; Jenson et. al., 2003; Voyles & Williams, 2004; Waite et al., 2007). We have relatively clear overall patterns of attitude, ability, and use, but the only way we are going to understand and address gender differences is to conduct interviews and observe actual behaviour. The wealth of survey data has left us at the mercy of speculation, some of which may be true, but little of which is supported by empirical data.

Developing Intervention Strategies

While no comprehensive model exists to explain the dynamics of gender and technology, the proposed model in Figure 1, provides a starting point for intervention research. Only 2 of the 71 studies (Jenson et al., 2003; Kay, 2006) examined how gender biases might change. Kay (2006) provided evidence that an 8-month, ubiquitous laptop program eliminated computer attitude, ability, and use differences in favour of males. Establishing a meaningful, supportive culture of computer use may be a substantial step toward producing effective intervention.

As Sanders (2006) suggest, more intervention studies are needed, and data from the last decade indicate that modifying affective attitudes and self-efficacy in middle school, high school, and university are reasonable areas to start. Of course, one could argue that more information on what causes gender differences is needed to create effective intervention. On the other hand, intervention research can provide useful feedback for understanding and addressing the computer gender gap in specific areas.

CONCLUSION

As with any large-scale review of the literature, more questions than answers are generated. In this specific review of gender and computer-related behaviour over the past decade, the following conclusions were made:

- Males have significantly more positive affective attitudes toward computers, particularly in high school, university, and the general workplace

- Gender bias in attitudes toward computers is affected by context – males have more positive attitude in school, but females have more positive attitude in an online environment
- Gender differences with respect to computer attitude have remained relatively stable for the past 10 years
- Males in a university or general workplace setting have consistently reported stronger computer skills for the past 10 years, however, these differences disappear when one looks at actual computer performance
- Males report significantly higher computer self-efficacy than females
- Males report higher computer use, however, this gender bias has decreased markedly over the past 10 years
- Males report more computer use at home, but not in school
- When looking at computer behaviour, males and females appear to act differently, but there appear to be no significant advantages for either sex

It is important to note that when we are talking about gender bias, even in the most extreme case, there are no differences between males and females 50% of the time. In short, male and female computer attitudes, ability, self-efficacy, and use are more similar than different.

Only two studies (Anderson & Haddad, 2005; Ong & Lai, 2006) looked toward developing a model to understand and explain gender differences. A model was proposed in this chapter to help understand current findings, and to direct ~~and focus~~ future research efforts. The new research agenda needs to improve and expand methodology, include underrepresented populations, consider the context of computer use, and explore intervention strategies.

The importance of investigating gender and technology is best illustrated from a comment made by one of the girls who learned in a same-sex environment in Jenson et al.'s (2003) study. She said:

When you taught us, it was simple. And I think one of the parts about … you … teaching us is that it feels nice when people go 'oh you are so smart, you know how to do this' …But like… if you ask a boy, 'oh could I have some help here,' they kind of laugh at you and say 'You don't know that?' … You are like giving us an opportunity where we … can say 'hey this is good maybe I will get into computers. (p. 569)

If what this girl felt is representative of the larger high school population where mixed sex education is the norm, then we cannot start early enough in rectifying this kind of prejudice. Ultimately, we need to create supportive environments that do not inhibit learning or choice with respect to using computers. It is also revealing that when efforts are made to create technology-rich environments that emphasize constructive, collaborative, problem-based learning, looking at authentic activities, no differences are reported between males and females with respect to attitude, self-efficacy, use, and performance (Mayer-Smith, Pedretti, & Woodrow, 2002). Perhaps, when technology is not the main focus but naturally and effectively integrated into a learning environment, gender biases are reduced or eliminated.

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APPENDIX

List of Papers Reviewed for this Chapter

Authors	Location	Val	Rel	Education	n	Context	Constructs
Anderson & Haddad, 2005	US	Yes	Yes	University	109	Online	Att, Abil, SE, Beh, M
Andriason, 2001	Sweden	No	No	Graduate	60	Online	Att, Beh
Atan et. al., 2002	Malaysia	No	No	University	315	Home	Use
Aust et. al., 2005	US	No	Yes	Preservice	265	School	Abil
Barrett & Lilly, 1999	US	No	NA	Graduate	14	Online	Att, Beh
Broos & Roe, 2006	Belgium	Yes	Yes	Grade 9 -12	1145	School	Att, SE
Broos, 2005	Belgium	Yes	Yes	Gen Pop	1058	General	Att, Abil
Brosnan & Lee, 1998	HK	No	No	University	286	School	Att, Abil
Brosnan, 1998	UK	No	No	University	119	School	Att, Beh, Use
Christensen et al., 2005	US	Yes	Yes	Grade 1 - 5	308 to 4632	School	Att
Colley & Comber, 2003	UK	No	Yes	Grade 7 & 11	344 to 575	General	Att, SE, Use
Colley, 2003	UK	No	No	Grade 7 & 11	213 to 243	General	Att
Comber et. al., 1997	UK	No	Yes	Grade 9-12	135-143	General	Att, Abil, SE, Use
Crombie et al., 2002	Canada	No	Yes	Grade 9-13	187	SG	Att, Abil, SE, Beh,
Durndell & Haag, 2002	Romanian	No	Yes	University	150	School	Att, SE, Use
Durndell & Thomson, 1997	UK	No	No	University	165	Home	Use
Durndell et. al., 2000	European	Yes	Yes	University	348	General	SE
Enoch & Soker, 2006	Israel	No	No	University	36430	General	Use
Fan & Li, 2005	Tawain	No	NA	University	940	School	Ability
Fitzpatrick & Hardman, 2000	UK	No	No	Grade 1-5	120	School	Att, Abil, Beh
Garland & Noyes, 2004	UK	No	Yes	University	250	School	Attitude
Goldstein & Puntambekar (2004)	US	No	Yes	Grade 6-8	159	School	Att, Abil, Beh
Graham et. al., 2003	Canada	No	No	Grade 9 -12	2681	School	Use, Beh
Guiller & Durndell, 2006	UK	No	No	University	197	Online	Behaviour
Jackson et. al., 2001	US	No	Yes	University	630	General	Use
Jenson et. al., 2003	Canada	No	No	Grade 6-8	54	SG	Abil, Intervention
Joiner et al., 2005	UK	No	Yes	University	608	Online	Att, Use
Joiner, 1998	UK	No	No	Grade 6-8	32	School	Attitude
Karavidas et. al., 2005	US	No	Yes	Gen Pop	217	General	Abil, Use
Kay, 2006	Canada	Yes	Yes	Preservice	52	School	Intervention
Kimbrough, 1999	US	No	No	University	92	Online	Abil, Use, Beh
King et. al., 2002	Australia	Yes	No	Grade 6-12	314-372	General	Attitude
Lanthier & Windham, 2004	US	No	Yes	University	272	General	Att, Use, Beh
Lee, 2003	HK	No	No	University	436-2281	School	Att, Abil
Leonard et al., 2005	US	No	No	Grade 1-5	73	School	Abil, Use, Beh
Li & Kirkup, 2007	UK & China	No	Yes	University	220	General	Att, Abil, Use
Light et. al., 2000	UK	No	No	Grade 6-8	62	SG	Att, Abil, Beh
Lightfoot, 2006	US	No	No	University	596	Online	Behaviour

continued on following page

Mayer-Smith et al., 2000	Canada	No	No	Grade 9 -12	81	School	Abil, SE, Use
McIlroy et. al., 2001	UK	Yes	Yes	University	193	General	Att
Mercier et al., 2006	US	No	Yes	Grade 6-8	86-102	General	Att, Abil, SE
Miller et. al., 2001	US	No	No	Grade 6-8	568	Home	Att, Abil, Use, Beh
North & Noyes, 2002	UK	No	No	Grade 6-8	104	General	Att
O'Neill & Colley, 2006	UK	No	No	Graduate	136	Online	Beh
Ong & Lai, 2006	Tawain	Yes	Yes	Gen Pop	156	General	Att, SE, M
Ono & Zavodny, 2003	US	No	No	Gen Pop	50000	General	Use
Oosterwegel et. al., 2004	UK	No	No	Grade 6-8	73	General	Att, SE
Ory et al., 1997	US	No	No	University	1118	Online	Att, Abil, Use, Beh
Papastergiou & Solomonidou, 2005	Greece	No	No	Grade 9 -12	340	School	Use
Passig & Levin, 1999	Israel	No	No	Kindergarten	90	School	Abil, Beh
Price, 2006	UK	No	No	University	268	School	Abil
Ray et. al, 1999	US	Yes	Yes	University	62	General	Att, Use
Sax et al., 2001	US	No	No	University	272821	General	Use
Schumacher et al., 2001	US	No	No	University	225	General	Abil, Use
Shapka & Ferrari, 2003	Canada	No	Yes	Preservice	56	School	Att, Abil, Use
Shashani & Khalili, 2001	Iran	No	No	University	375	Family	Att, SE
Shaw & Marlow, 1999	UK	No	No	University	99	General	Att, Beh
Smeets, 2005	Netherlands	No	No	Gen Pop	331	School	Beh
Solvberg, 2002	Norway	No	No	Grade 6-8	152	Home	SE, Use
Sussman & Tyson, 2000	US	No	Yes	Gen Pop	701	Online	Beh
Thayer & Ray, 2006	US	No	Yes	University	174	Online	Attitude
Todman & Day, 2006	UK	Yes	Yes	University	138	General	Attitude
Todman, 2000	UK	No	Yes	University	166-202	General	Attitude
Tsai et. al., 2001	Tawain	Yes	Yes	Grade 9 -12	753	Online	Att, SE
Volman et. al., 2005	Netherlands	No	No	Grade 1 -5	94-119	School	Att, Abil, Use
Voyles & Williams, 2004	US	Yes	No	Grade 7-8	57	School	Abil, SE, Beh
Waite et al., 2007	UK	No	No	Grade 1-5	7	School	Behaviour
Wu & Hiltz, 2004	US	Yes	Yes	University	116	School	Att, Abil
Young, 2003	US	No	No	Grade 7-8	462	General	Att, Abil, SE, Use
Yuen & Ma, 2002	HK	Yes	Yes	Preservice	186	General	Attitude
Zhang, 2005	US	No	Yes	Gen Pop	680	General	Attitude