*Information Technology in Childhood Education Annual* (2003), 5-27

# An Analysis of the Influence of Gender, Grade Level, and Teacher on the Selection of Mathematics Software by Intermediate Students

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The purpose of this study was to investigate the relationships between gender, grade level, teachers, and the selection of mathematics software as measured by the type of mathematics software chosen, and time-on-task. Research data were collected from 202 third, fourth, and fifth grade students in a single elementary school located in northeastern Colorado.

Intermediate students were introduced to four different pieces of mathematics software during instructional time and then asked to choose one as their favorite. Results from this study indicate no gender or grade level differences in software selection. Outcomes from the study did however show significant differences in time-on-task by gender and grade level. These data resulted in some commonalties and several deviations from the prior research in the area. Results of this study are discussed in comparison to previous research and recommendations for future research in gender selection of software are included.

There is overwhelming evidence of male dominance in the fields of math and technology. Software developers and engineers are predominantly males and they design software programs to meet a huge consumer demand from men and boys. Do women have poor math and computer literacy skills or do they not value these skills? Do women need software designed specifically for them or should software be more gender neutral?

In the early 1960s, computers were thought to be a means for overcoming gender discrimination in the classroom (e.g., Briggs, 1967; Skinner, 1968; Stein & Smithells, 1969; Weisgerber, 1968). The use of computer-based instruction was introduced, studied, and then left for future educators to implement (Mandell & Mandell, 1989). As computers have become pervasive in schools at all levels (Collis et al., 1996), it has become even more important for women to have an equal input in the way we conduct business, run our homes, and entertain ourselves (Collis et al., 1996).

A few studies have focused on the importance of producing gender neutral software women and girls can feel more comfortable using (e.g., Bradshaw, Clegg, & Trayburn, 1995; Laurel, 1998; Miller, Chaika, & Groppe, 1996; Spender, 1999). After interviewing 1,100 females across the country, Laurel (1998) reported that girls did not feel entertainment software on the market met their needs. Girls, like boys, need challenging, complex, adventurous, and clue-based software (Laurel, 1998). If girls are more comfortable and interested, they will spend more time with computers and instructional software. Children in our classrooms will simply not use software, which does not meet the needs and preferences of both males and females.

Apple Classrooms of Tomorrow (Dwyer, Ringstaff & Sandholtz, 1990) research indicates the use of computers in the classroom can have a profound effect on the teacher's role in and delivery of instruction. Sandholtz, Ringstaff, and Dwyer (1994a) reported that the introduction of technology within classrooms can significantly increase student enthusiasm and engagement time when used as a tool integrated within the total curricular framework.

This research focused on male and female elementary students' time-on-task and selection of mathematical computer software. This study provides recommendations to educators and software designers about the types of mathematics software boys and girls prefer to use at the intermediate grade levels.

## REVIEW OF LITERATURE

> The great quest in the field of media and technologies of instruction is to find ways of matching individual learners with the appropriate subject matter, pitched at the right level, and presented in a compatible

> medium at the optimal pace in the most meaningful sequence. (Heinich, Molenda, Russell, & Smaldino, 1999, p. 220)

Because computers are playing an ever-increasing role in our society and classrooms, it is important to understand how students interact with the technology available to them. The potential of instructional technology appears to lie in its ability to support diverse learners and encourage a learner-centered environment (Brunner & Bennett, 1997; Collis et al., 1996; Urban, 1986).

## Gender

Though grounded in the 1980s, gender equity literature describes characteristics typical of males and females in the educational setting and is not refuted today.

> The education system, as one of the major socializing institutions, has an important role in the teaching of cultural values and beliefs to children. Some researchers believe that schools are developing and reinforcing segregation of the sexes and promoting sex-role stereotypes and discriminations. These actions exaggerate the negative aspects of sex roles in the outside world when, in fact, they should be alleviating them. (Delamont, 1980, p. 9)

Girls prefer working in cooperative groups or pairs, while boys more often choose to work alone (Moore, 1986; Spender, 1989). Girls tend to spend more time with their friends and have a greater tendency to ask peers for help (Moore, 1986). Females, in general, have been taught to negotiate and compromise, but males are encouraged to be competitive and decisive (Martin & Hearne, 1989). Males have a tendency to be more aggressive, but girls will often defer to boys in order to avoid hostility (Lockheed, 1985). Males are inclined to have stronger views of what is appropriate for girls and boys. In coeducational classes, boys demand and receive more of the teacher's attention and other resources such as books, equipment, and computers (Fisher, 1984; French, 1984; Whyte, 1986). Teachers often prefer teaching boys because males are easier to talk to, more outspoken, and more willing to exchange ideas. Teachers do, however, feel that girls are easier to discipline (Moore, 1986).

## Age

Ormrod (1995) believed “mathematics anxiety is so prevalent because most schools teach too much, too fast, and too soon, so that students quickly begin to associate mathematics with frustration and failure” (p. 42). Part of the problem could also be that students are taught mathematical concepts before they are cognitively ready. Piaget felt many children don’t acquire certain capabilities for mathematical reasoning until they are 11 or 12 years old. He identified four stages of development a child goes through as s/he grows (Piaget, 1972; Piaget & Inhelder, 1969). It is possible the intermediate students in this study may fall into three of Piaget’s stages: (a) pre-operational, (b) concrete operational, and (c) formal operational.

A few of the third grade students may still be at the pre-operational stage, which occurs when a child is between two and six or seven years of age. During this stage a child begins to develop language and the ability to think in symbolic form. Pre-operational children are able to think operations through logically, but just in one direction. Students at this stage need manipulatives, hands-on practice, and short directions during mathematics instruction (Barbieri & Light, 1992; McInerney & McInerney, 1998; Ormrod, 1995; Piaget, 1972; Piaget & Inhelder, 1969).

## Time-on-Task

“The possible relationship between time and learning has increasingly interested educators for the past two decades” (American Association of School Administrators, AASA, 1982). Harniischfeger and Wiley (1976) found the more time a student spends on a subject, the better the student’s performance.

The AASA study (1982) suggested if engaged time can be increased, higher achievement will follow. The authors continued, “…time-on-task is not a magic wand….It is rather, a valuable tool that, when used with care, can play an important part in building student achievement” (AASA, 1982, pp. 53-54). Anderson (1976), Karweit (1988), and Walberg (1988) found increased time-on-task positively correlated with increased motivation as well. The amount of engaged or on task time is positively related to the amount of learning evidenced by higher achievement scores, better retention of learning, and more positive attitudes toward school (Lindquist, 1980).

Clark (1983), in a meta-analysis on learning from media, concluded research in the field of Educational Technology should focus on the characteristics of instructional methods and suggested “outcome measures are typically some measure of learner persistence at a task" (p. 457). Recently the Commission of Technology in Teaching and Learning (CTTL) awarded a grant to the Stanford Language Center for a study entitled, "Increasing Instructional Time - Enhancing Engaged Time: Evaluating the Instructional Import of the Stanford Digital Language Laboratory." The CTTL project will assess, in part, the impact of increased amounts of language learning time on student and instructor performance. The researchers conducting this project believe that time-on-task is the most critical factor in any instructional setting, quantitatively (amount of time) and qualitatively (the nature of the activities conducted during allotted time) (Thomsen, 1998).

### Math and Technology

There is a great deal of debate concerning the role of computers in the mathematics curriculum. Computers, according to Steen (1989), have a strong impact on teaching in the K-12 classroom, but they don't become essential until the second year of college. Other researchers contend computers should be part of mathematics instruction right from the beginning of school (e.g., Kaput & Thompson, 1994; Schwartz, 1992). Advocates of the role of computers in schools believe these machines offer increased flexibility in the way students can experience mathematics (Roblyer, Edwards, & Havriluk, 1997). Kaput and Thompson (1994) believed "[Y]ou can't really achieve what the (math) standards suggest without technology" (p. 683). One of the major forces behind most changes in mathematics instruction today is the result of the Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics (NCTM), 1989). This document calls for major revisions in the methods used to teach mathematics in order "to ensure that all students have an opportunity to become mathematically literate … and become informed citizens capable of understanding issues in a technological society" (NCTM, 1989, p. 4).

### Teacher Influence

Research has been completed over the past ten years on the influence of technology in a classroom on teaching and learning (AAUW, 1998; Baker & O'Neil, 1994; Dwyer et al., 1990; Kulik, Bangert, & Williams, 1994; Ringstaff, Sandholtz, & Dwyer, 1991; Ringstaff, Yocam, & Marsh, 1996; Sandholtz, Ringstaff, & Dwyer, 1997; Sandholtz et al., 1994a; Sandholtz, Ringstaff, & Dwyer, 1997). These studies have investigated instructional methods, teacher training, student engagement, and student expertise.

Sandholtz et al. (1994a), reported student engagement increased with the introduction of technology under certain conditions. First the authors found technology to positively impact student engagement when it was the most appropriate tool among many. Second, the use of technology needed to be integrated into the entire curriculum, not isolated as an activity in and of itself. Student engagement was more enduring when teachers emphasized the use of tool applications where students could explore and experiment. Finally, this study found student engagement was improved when teachers adjusted the use of technology to individual differences. “When students are actively engaged and involved in a task, learning is a likely result” (p. 17). Kulik, Bangert, and Williams (1994), in a meta-analysis, found students learn their lessons in less time with computer-based instruction.

## RESEARCH QUESTIONS

This study proposed a further investigation of gender preferences when selecting and using mathematics software. The overarching research question was:

> What relationship is there between gender, grade level, teachers, and the selection and use of mathematics software as measured by the type of mathematics software chosen, and time-on-task?

This question was explored with the following specific research questions.

RQ1 - Does the type of mathematics software chosen differ significantly between male and female intermediate students?

RQ2 - Does the type of mathematics software chosen differ significantly between third, fourth, and fifth grade students?

RQ3 - Does the type of mathematics software chosen differ significantly between intermediate teacher’s classrooms?

RQ4 - Does time-on-task based on mathematics software selected differ significantly between males and females?

RQ5 - Does time-on-task based on mathematics software selected differ significantly between third, fourth, and fifth grade students?

The research questions, explored through research hypotheses, focused on the relationships between gender, grade level, teachers, selection of mathematics software by intermediate students, and time-on-task. Results from this study add to the gender bias knowledge base and provide suggestions for software developers for improving movement toward gender equity in software design. The future for women in the field of technology is tenuous at best (Harrell, 1998). With the new millennium, every effort should be made to promote not only equality, but equity as well. The obstacles females face eventually translate into highly paid men dominating the engineering and computer science arenas while women are relegated to data entry and word processing (Hakansson, 1990; Henwood, 1993). This study added insight into factors that may influence this trend during the age range where females begin to lose their interest in computing, between third and fifth grade (Harrell, 1998; Hopkins, McGillicuddy-DeLisi, & DeLisi, 1997).

## DESIGN

### Study Population

The study population consisted of all potential intermediate students from an elementary school within a semi-urban public school district in northern Colorado. The population represented eight percent of the intermediate students in the district. These students were divided into grade level as well as gender groups. Gender, grade identification, and age were obtained from the school files and the children were then grouped into the six categories.

Two hundred twenty-three of the 235 students returned a permission slip to participate in the research, representing a 95% return rate. Some students were not included in the study due to severe disabilities, missed training sessions, and incomplete data. The sample population of 202 students was 86% of the school's intermediate population and 91% of the students who returned their permission forms. Student confidentiality was protected with a coding system that coded student numbers to classroom teachers (e.g., 101 for teacher "10" and student "1").

Letters were sent home to all of the students' parents prior to the treatment explaining the study and assuring them that their child's responses would be kept anonymous and confidential. Consent forms were included for parents/guardians to sign so that their child could participate in the study. If students were not given permission to participate, their names were removed from the pool of 235 students. These students did, however, participate in the instructional portion of the study so that they were not excluded from the rest of their peers and the learning experience. At the time the study was conducted, the researcher explained the rationale to the students and assured them their responses would be kept anonymous and confidential.

Participants benefited from this study because they had the opportunity to interact with mathematics software, adding to their repertoire of educational tools. Risk to participants was minimal because the researcher followed guidelines set forth by the Internal Review Boards of the University, the school district, and the American Psychological Association (APA, 1992). The researcher maintained a scientific role and conducted the research within the boundaries of her competence.

## Selection of Software for the Study

For the purpose of evaluation and selection of appropriate software, the researcher referred to the efforts of experts in the field such as Bitter and Camuse (1988), Bitter and Pierson (1999), Mandell and Mandell (1989), and Merrill et al. (1996); consulted organizations such as Educational Software Institute (ESI) and Northwest Educational Technology Consortium (NETC) guidelines found on the Internet; and used the work being done by universities such as Vanderbilt, the University of Sydney, Southern Illinois University, and Southwest Missouri State. Although there were a number of evaluation tools, none was as encompassing as needed. Subsequently, several well known instructional software companies were contacted and asked to identify which products they market within the categories of drill and practice, instructional game, simulation, and tutorial software. A list, generated from these contacts, was compiled and then compared against evaluations previously done by students, teachers, and educational associations. The single piece of mathematics software from each category with the highest cumulative rating, which was not currently being used by the students at the school where the study was conducted, was selected for the study.

This study defined drill and practice as software designed for the repetitive practice of a specific task, such as memorizing addition facts or multiplication tables. This type of program is often in a "flashcard" format (Salisbury, 1988). For this study, *Professor Finkle's Times Table Factory*© was the mathematics drill and practice software used. This study defined Instructional Game as software that involves competition between a student and one or more opponents. The opponent may or may not be a computer. For this study, *Awesome Animated Monster Maker*© was the mathematics instructional game software used. Simulation software, for this study, is defined as software that models real-life situations so students can experience certain phenomena vicariously and with little risk (Roblyer et al., 1997). For this study, *Math Shop Deluxe*© was the mathematics simulation software used. Finally, Tutorial is defined as software designed to teach new information through a structure of present, practice, test, and then perhaps remediate (Roblyer et al., 1997). For this study, *Larson's LeapFrog Math*© was the mathematics tutorial software used.

### Time-on-Task

A Self-Reporting Time Sheet was used by the students to record their time-on-task. This instrument consisted of three columns: (a) software title, (b) start-time, and (c) end-time. The students used the time sheet during the free exploration time they were given after being introduced to each of the four software choices. The intent of this instrument was simply to log time-on-task as well as document mathematics software preference. This instrument was piloted with intermediate age students for reliability prior to the study with a 96% accuracy rate.

### Administration

The researcher trained the facilitator (media instructor) who conducted computer classes in the school, in the use of the four examples of mathematics software, reviewing key objectives, capabilities, and characteristics of each program prior to student sessions. The facilitator delivered the instruction, using a didactic approach with the researcher serving as an observer. A didactic approach to instruction is one in which the instructor assumes total control of the learning environment. Hopkins et al. (1997) found when a didactic approach of instruction was used in mathematics, female third and fifth grade students performed with greater success than they did with a constructivist approach. The boys in the Hopkins' study, however, showed equal gains with both approaches. Because females performed better and males worked equally well with a didactic approach, the author chose it as the method of delivering the software instruction.

All students were introduced to each of the four categories of mathematics software during half-hour sessions, a total of two instruction hours (Sessions 1-4), within a two-week time frame. The software delivery sequence was randomized so the order in which the software was taught did not affect decisions students made during the free selection time.

Once the instruction had been completed the investigator took the classes into the computer laboratory for their free selection time (Session 5). Students were asked to record the title of the favorite piece of mathematics software they had used during the four previous instructional sessions. Students were asked to record their start time when they began working and end time when they were finished working with the software they had chosen. The children were also told they could work on any other software title they had used during the study, but they must also record their second, third, and/or fourth choices in the same manner they recorded the first one. A large digital clock was placed at the front of the room so students were able to easily read and record the time. At the end of the one-hour free selection time, the Self-Reporting Time Sheets were collected and the time-on-task calculated.

## RESULTS

Testing the null hypotheses posed by this study involved the use of several data analysis techniques. Chi-square tests of independence, with alpha set a priori at .05, were conducted to determine whether variables were related or independent. Analysis of Variance (ANOVA) tests were used to test the differences between the time-on-task means by software and gender, grade level, and teacher, the Student-Newman-Keuls test was used as a posthoc measure when the ANOVA was statistically significant.

It was necessary to reorganize the number of software cells due to the unpredictability of the software choices made by the children. This reorganization was necessary because of the relatively few students who chose drill and practice ($n$ = 8) or tutorial ($n$ = 13) software. The four categories of mathematical software were collapsed into three categories: drill and practice/tutorial (a), instructional game (b), and (c) simulation for data analysis purposes. Table 1 provides the frequencies for students' first choice of mathematics software after the cells were collapsed.

**Table 1**

Collapsed Software Selection—First Choice (∝ < .05)

| Group | D & P/Tutorial | | Inst. Game | | Simulation | | Total |
|---|---|---|---|---|---|---|---|
| | Girls | Boys | Girls | Boys | Girls | Boys | |
| Third | 10 | 1 | 14 | 18 | 15 | 18 | 76 |
| Fourth | 3 | 5 | 11 | 12 | 17 | 17 | 65 |
| Fifth | 2 | 0 | 15 | 13 | 13 | 18 | 61 |
| Total | 15 | 6 | 40 | 43 | 45 | 53 | 202 |

### First Choice by Gender

The investigation of gender and choice resulted in no statistical difference ($x^2$ = 4.60, $p$ = .1003) between the choices students made when selecting software. The chi-square goodness-of-fit tests resulted in a significant difference ($E\ x^2$ = 3.84, $O\ x^2$ = 4.1) between male and female students who preferred drill and practice/tutorial mathematics software with girls ($n$ = 15) choosing drill and practice/tutorial software more often than boys ($n$ = 6).

**Table 2**

Results of Chi-square for Gender and Software Selection (∝ < .05)

| Group | *n* | D & P/ Tutorial | Inst.Game | Simulation | chi-sq. | *df* | *p* |
|---|---|---|---|---|---|---|---|
| Girls | 100 | 15 | 40 | 45 | 4.60 | 2 | 0.1003 |
| Boys | 102 | 6 | 43 | 53 | | | |
| Total | 202 | 21 | 83 | 98 | | | |

The chi-square test goodness-of-fit results for gender and instructional game software selection showed there was no significant difference ($E\ x^2$ = 3.84, $O\ x^2$ = 0.110) between girls ($n$ = 53) and boys ($n$ = 45) choosing instructional game mathematics software. The chi-square goodness-of-fit test results for gender and simulation software selection showed the differences between male ($n$ = 53) and female ($n$ = 45) students choosing simulation mathematics software were not statistically significant ($E\ x^2$ = 3.84, $O\ x^2$ = 0.640).

## First Choice by Grade

The investigation of grade level and choice of mathematics software (drill and practice/tutorial, instructional game, simulation) indicated no significant differences between proportions of third, fourth, or fifth grade students' choice of mathematics software ($x^2$ = 5.96, $p$ = .2022).

**Table 3**

Results of the Chi-square for Grade and First Choice (µ < .05)

| Group | *n* | D & P/ Tutorial | Inst. Game | Simulation | chi-sq. | *df* | *p* |
|---|---|---|---|---|---|---|---|
| 3 | 76 | 11 | 32 | 33 | 5.96 | 4 | 0.2022 |
| 4 | 65 | 8 | 23 | 34 | | | |
| 5 | 61 | 2 | 28 | 31 | | | |
| Total | 202 | 21 | 83 | 98 | | | |

The chi-square goodness-of-fit test results for grade level and drill and practice/tutorial software selection showed significant differences ($E\ x^2$ = 5.99, $O\ x^2$= 5.999) between the proportion of third, fourth, and fifth grade students choosing drill and practice/tutorial software. The test indicated third graders ($n$ = 11) were more likely to use drill and practice/tutorial software than fourth or fifth graders. The chi-square goodness-of-fit test results for grade level and instructional game software selection showed no statistical difference ($E\ x^2$ = 5.99, $O\ x^2$= 1.7856) between the proportion of third, fourth, and fifth grade students who chose instructional game software. The chi-square goodness-of-fit test results for grade level and simulation software selection showed no statistical difference ($E\ x^2$ = 5.99, $O\ x^2$= 0.1515) between the proportion of third, fourth, and fifth grade students who chose simulation software and the null hypothesis was retained.

## First Choice by Teacher

The investigation of teacher and choice indicated there were statistical differences between the choices of students based on the classroom teacher ($x^2$ = 33.08, $p$ = 0.0163). Teacher four's students chose the simulation software ($n$ = 15) as their first choice more often than the instructional game ($n$ = 8), but none of her students chose the drill and practice/tutorial software. Teacher six's students chose the instructional game ($n$ = 14) as their first choice more often than the simulation ($n$ = 8) and none of her students chose the drill and practice/tutorial software. Teacher eight's students chose the simulation (*n* = 17) as their first choice more often than the instructional game (*n* = 6) and none of her students chose the drill and practice/tutorial software.

**Table 4**

Results of Chi-square for Teacher and First Choice (μ < .05)

| Group | *n* | Grade | D & P/ Tutorial | Inst. Game | Simulation | chi-sq. | *df* | *p* |
|---|---|---|---|---|---|---|---|---|
| 1 | 16 | 5 | 2 | 8 | 6 | 33.08 | 18 | 0.0163* |
| 2 | 22 | 3 | 4 | 8 | 10 | | | |
| 3 | 20 | 4 | 2 | 9 | 9 | | | |
| 4 | 23 | 4 | 0 | 8 | 15 | | | |
| 5 | 19 | 3 | 3 | 7 | 9 | | | |
| 6 | 22 | 5 | 0 | 14 | 8 | | | |
| 7 | 19 | 3 | 1 | 7 | 11 | | | |
| 8 | 23 | 5 | 0 | 6 | 17 | | | |
| 9 | 16 | 3 | 3 | 10 | 3 | | | |
| 10 | 22 | 4 | 6 | 6 | 10 | | | |
| Total | 202 | | 21 | 83 | 98 | | | |

Note. 33% of the cells had expected counts less than 5 so the chi-square may not provide a valid result.

A chi-square test of independence was conducted to compare teacher and choice of mathematical software (drill and practice/tutorial, instructional game, simulation). Results should be interpreted with caution because 33% of the cells had expected counts less than five, thus the chi-square may not provide a valid result.

## Time-on-Task by Gender

The 2 x 3 ANOVA, which investigated time-on-task and gender, indicated there was not a significant interaction ($F = .11$, $p = .8963$), between gender and software choice.

**Table 5**

Results of ANOVA for Time-on-Task by Gender and First Choice (μ < .05)

| **Group** | ***df*** | ***SS*** | ***MS*** | ***F*** | ***p*** |
|---|---|---|---|---|---|
| Gender | 1 | 603.07 | 603.07 | 5.10 | 0.0250* |
| First Choice | 2 | 1884.83 | 942.42 | 7.98 | 0.0005* |
| Gender*First | 2 | 25.89 | 12.94 | 0.11 | 0.8963 |

There was a significant main effect by gender on time-on-task ($F$ = 5.10, $p$ = .0250) with boys ($m$ = 28.13) spending more time with their choice of software than did girls ($m$ = 25.21). There was also a significant difference found for the average amount of time spent by software choice ($F$ = 7.98, $p$ = .0005). Students spent more time working with simulation software ($m$ = 31.26) than with drill and practice/tutorial software ($m$ = 21.79) or instructional game software ($m$ = 26.97). Boys consistently spent more time-on-task than did girls across all software choices. Simulation software ($n$ = 98) was the most popular of the three programs and also had the greatest mean time-on-task ($m$ = 31.26).

## Time-on-Task by Grade

The 3 x 3 ANOVA used to analyze time-on-task and grade level indicated no significant interaction ($F$ = 1.58, $p$ = .1808) between grade level and software choice.

**Table 6**

Results of ANOVA for Time-on-Task by Grade and First Choice (μ < .05)

| **Group** | **df** | **SS** | **MS** | **F** | **p** |
|---|---|---|---|---|---|
| Grade | 2 | 1038.70 | 519.35 | 4.54 | 0.0118* |
| First Choice | 2 | 912.89 | 912.89 | 7.98 | 0.0005* |
| Grade*First | 4 | 723.70 | 180.93 | 1.58 | 0.1808 |

There was a significant main effect of grade level on time-on-task ($F$ = 4.54, $p$ = .0118) with fourth ($m$ = 29.75) and fifth ($m$ = 30.74) grade students spending more time with their choice of software than did third grade student ($m$ = 25.62). There was also a significant main effect found for the average amount of time spent by software choice ($F$ = 7.98, $p$ = .0005).

Fifth grade students consistently spent more time-on-task than fourth graders across all software choices. A similar pattern was found with fourth grade students consistently spending more time-on-task than third grade students. A post-hoc Student-Newman-Keuls test was conducted to determine which grade level might have affected the outcomes. The mean for fourth ($m$ = 27.50) and fifth (m = 28.48) grade students did not differ significantly, however the mean for third (m = 24.48) graders differed significantly from the other two grade levels.

The Student-Newman-Keuls analysis for time-on-task by selection found the means for the simulation ($m$ = 31.34) and instructional game ($m$ = 27.02) software did not differ significantly, however the means for the drill and practice/tutorial ($m$ = 21.05) software differed significantly from the other two.

## DISCUSSION

The analyses of this study revealed few significant differences for gender and grade level selection of software. However, the individual teacher was found to play a significant role in student choices. These analyses both confirm and dispute prior research on software selection which noted girls prefer drill and practice software (Culley, 1993; Martin, 1991; Nelson & Watson, 1991; Sanders, 1985, 1995; Shrock, Matthias, Vensel, & Anastasoff, 1985), while boys prefer gaming software (Huff & Cooper,1987; Laurel, 1998; Malone & Lepper, 1980; Sanders, 1995). The results for time-on-task by gender and grade level all showed significant differences which also disputes earlier findings (Martin, 1991; Murphy & Gipps, 1996).

### Software Selection

Software selection by gender, grade level, and teacher variables was a primary focus of this study. Students in this study chose the drill and practice/tutorial mathematics software less often than either the instructional game or simulation mathematics software. The instructional game and simulation mathematics software were both more interactive than the drill and practice/tutorial software and allowed the students to select from a variety of activities within the software. It is possible students in today's classrooms have reached a level of sophistication where traditional software no longer satisfies their needs or expectations.

When using drill and practice/tutorial software, this study confirmed prior research finding girls prefer drill and practice software and using computers as a tool for learning (Culley, 1993; Martin, 1991; Nelson & Watson, 1991; Sanders, 1985, 1995; Shrock, Matthias, Vensel, & Anastasoff, 1985). Girls (*n* = 15) were significantly more likely to use drill and practice/tutorial software than boys (*n* = 6). Studies conducted by Huff & Cooper (1987), Laurel (1998), Malone and Lepper (1980), and Sanders (1995) all found boys are more likely to prefer gaming software than girls. Results from the statistical analysis of this study dispute these results previous findings, as the proportion of girls (*n* = 40) and boys (*n* = 43) who chose instructional game software was not statistically different. Differing results, however, could be due to the fact the software in this study was an instructional game as opposed to a recreational game or perhaps because these students had been taught to use the software during the study. The simulation software used in this study was composed of two distinct sections. The first section asked students to work in stores to solve problems and earn money. Previous studies (Malone & Lepper, 1980; Laurel, 1998) have indicated girls prefer working with problem solving software. The second section of the simulation software allowed students to spend the money they had earned in the shops, playing arcade games. The proportion of girls (*n* = 45) and boys (*n* = 53) who chose simulation software was not significantly different. There is a void in the literature concerning student selection of simulation software. It is possible, however, the two very different sections in the simulation software (gaming and task-oriented skills) counterbalanced each other. Had the simulation software not included both sections, results may have differed.

Statistical analyses from this study indicate grade level had no effect on students' selection of mathematics software. The proportion of third, fourth, and fifth grade students who chose a particular type of software differed only by classroom teacher.

Apple Classrooms of Tomorrow (ACOT) research (Sandholtz, Ringstaff, & Dwyer, 1994b), as well as work completed by Lohr, Ross, and Morrison (1995) indicated the type of instructional delivery in a classroom affects the way students interact with their own learning process. When students work in a project-based learning environment enhanced with technology they become collaborators instead of competitors and begin to take responsibility for much of their own learning (Dwyer, Ringstaff, & Sandholtz, 1990). Statistical analysis from this study indicates a significant difference between teachers and the type of mathematics software their students selected as their favorite.

### Time-on-Task

This study clearly demonstrated a difference between the time girls and boys spent working with their favorite type of software, with boys consistently spending more time-on-task regardless of software choice than girls did. There were also significant differences in time-on-task by grade with fourth and fifth grade students consistently spending more time-on-task than third graders. These results are most likely an indication of student maturity level or perhaps a reflection of instructional methods used in their classroom.

Previous studies have advocated software designed solely for girls (Laurel, 1998; Sanders, 1995) or gender-neutral software (Eisenberg, 1997; Spender, 1997). Bradshaw, Clegg, and Trayburn (1995) cautioned that gender neutral software does not necessarily ensure lack of bias. Turkle (1984) suggested software that is bad for girls is probably just as bad for boys. Much instructional software continues to reinforce gender bias and gender roles. So called “pink software” tends to perpetuate gender stereotypes since it assumes girls want to design clothing, put on make-up, or babysit. Gender-neutral software often uses nongendered characters, which are condescending and unrealistic. Perhaps what is needed in schools is not gender neutral or “girly” software, but challenging courseware appropriate for both girls and boys. It is possible this study did not show significant differences by gender because the mathematics software which students had to choose from was carefully evaluated for content and gender bias prior to the study. The drill and practice/tutorial, instructional game, and simulation software all met good design criteria (e.g., nonviolent, based on a problem-solving format, multi-level, challenging, creative, goal focused, adventurous, user friendly, motivating, and required a certain level of skill). Software designers must consider the needs of technology savvy students of the 21$^{st}$ century and rethink design specifications that have traditionally been male oriented. Good software should be good for both girls and boys.

## RECOMMENDATIONS

Previous research suggests the gender bias gap in technology becomes wider as students progress through the K-12 educational setting. This study attempted to identify specific aspects of the gender bias problem as it might affect the selection of software among intermediate grade students.

While this study did not show significant differences for software selection by gender or grade level, it did show a difference by individual teacher. Further research into the factors underlying these differences is recommended. What attitudes do teachers have toward computers and technology integration in the classroom? What methods are these teachers employing in their classrooms that may affect the choices students make when working with software? The software used in this study was very carefully chosen to insure it was well designed, strongly recommended by several evaluation sources, categorized correctly, and free of gender bias. It is possible the software used in this study was all of such equally high caliber and free of bias, students were unable to make decisions based on concrete data, and therefore simply chose the one they considered the most fun. Depending on a child's personality and background, fun can take on many meanings perhaps extending even to instructional materials.

The time-on-task statistical results are worthy of further investigation. Significant differences were found for time-on-task by gender and grade level. Factors such as comfort level with computers, software design, maturity level, teaching style, or classroom management may have all played some part in students' recorded time-on-task. Future research into these variables could shed light on the reasons for the time-on-task differences observed in the study.

Finally, a longitudinal study investigating student use of software over a period of six years (K-5 setting) could be conducted to identify patterns of software selection and preference. Such a study could shed light on why students choose to work with different types of software at different age levels. Instead of organizing the software into the three categories of this study, courseware might be categorized into game, instructional, and productivity software.

## LIMITATIONS

Six main threats to validity were identified at the start of this study: mortality, selection, prior experience, novelty effect, knowledge of study, and unpredictability. The first, mortality, did not affect the results since less than 5% ($n$ = 11, $n_G$ = 5, $n_B$ = 6) of the students failed to complete all five sessions during the study. The second predicted limitation, selection, certainly affected interpretation of results. Because the subjects came from multiple intact class groups, generalizations to outside populations would be inappropriate. Prior experience could very well have affected the results of this study. The subjects all live in a relatively high tech community in a state becoming well known as the Silicon Mountain. It is quite possible students in the study had a higher comfort level with computers than students in another population. The students' familiarity with the mathematics software used in the study was probably negligible because the researcher very carefully investigated and subsequently eliminated any and all instructional software currently being used in the classrooms and computer laboratory. It is possible a novelty effect could have affected the results of this study since the one-hour self-selection time was a relatively short amount of time. Because students knew they were part of an experiment, knowledge of the study may have affected performance and attitude. Unpredictability, the fourth predicted limitation, did affect the outcome of the study. When the data were analyzed, it was necessary to collapse the original four types of mathematics software (drill and practice, instructional game, simulation, tutorial) into three groups (drill and practice/tutorial, instructional game, simulation).

## CONCLUSION

This study investigated the relationships between gender, grade level, teachers, and the selection of mathematics software to provide recommendations to educators and software designers about the types of mathematics software male and female students prefer to use at the intermediate grade levels. Although data from this study indicate no differences by gender for software selection, it did illustrate the impact teachers can have on students' software choices. It is important for teachers to be good consumers and evaluators of software. Many teachers have not experienced the technology rich background their students now typically exhibit. Teachers need instruction on how to seamlessly integrate technology into their classrooms, thoughtfully evaluate software, and they must be willing to share the responsibility of teaching and learning with their students.

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