The Effects of Using Computer Technology with Lower-Performing Students: Technology and Student Mathematics Achievement

Hosin Shirvani, University of Texas-Pan American, TX, USA

Abstract: The study examined whether lower-achieving students will benefit from the use of computers in their classrooms. The participants were freshman high school students, and 95% of them were either African-American or Hispanic. The researcher selected six Algebra I classes; three of them were placed in the experimental group and another three classes in the control group. There were 127 students with 65 students in the experimental and 62 of them in the control group. The study found that the lower-performing students in mathematics who used computer technology in their classrooms significantly outperformed other students who had no access to this technology. This study showed there were no significant differences in learning mathematics between learners in the two groups. On an attitude survey, this study discovered that students with computer-assisted technology developed better attitudes toward mathematics.

Keywords: Computer, Technology, Mathematics

Introduction

THE RESULTS OF the National Assessment of Educational Progress (NAEP), sponsored by the National Center for Statistics (NCES, 2007), indicated that 65% of the students who took the mathematics test were categorized as below proficiency level in 2007. The level of below proficiency in several states with a large percentage of minority students was as much as 78%. The Trends in International Mathematics and Science Study (TIMSS) has found that American students are underperforming when compared to most industrial nations (Martin et al., 2008). Due to the low performance of minority students and other special groups, the government has enacted a law, the NCLB Act of 2000 signed by George Bush, to raise children's performance in mathematics and reading. Also, many students have problems passing their state mathematics tests as one of the requirements for graduation. Moreover, many states have lowered their standards in mathematics in order to have a higher number of students passing their exit tests as required by the states where students are residing (Duncombe, et al., 2008). The literature review of research studies has provided educators with many strategies to improve mathematics achievement of students. One creative strategy in improving students' mathematics achievement is through integrating technology in a curriculum. The use of computers in improving student understanding of mathematical concepts has been investigated during the last thirty years (Kulik, 2003; Kulik & Kulik, 1987; Weaver, 2002; Suh and Moyer, 2007). Moreover, in recent years, the application of this technology in the field of acquisition of knowledge has grown in popularity due to its affordability in owning this tool and the ease of connectivity to the Internet. Teachers can use computers in creative ways to teach math-

The International Journal of Learning
Volume 17, Number 1, 2010, http://www.Learning-Journal.com, ISSN 1447-9494

COMMON GROUND

ematics; for example, one innovative strategy is using this technology through assisted tutorial. Also, teachers can enhance student learning through mathematical games or CD's which are provided by textbooks. Therefore, this study is significant because it will examine whether the use of technology-assisted instruction will improve students' mathematic achievement. Moreover, there is a gap in literature in studying the effects of this teaching strategy in improving mathematics achievement of lower-achieving minority students.

There are three purposes for implementing this study. First, this study contrasted the performance of students in an environment that uses computer technology to assist mathematics instruction and in one that is using a traditional math setting without the use of this technology. Second, the researcher is interested in finding whether there are significant differences in student mathematics achievement between lower-achieving and other students, who are average and higher achieving students. Third, the study examined whether there were significant differences in student attitudes toward mathematics between students in the two groups.

Effects of Computer Technology on Learning

The use of computers in schools increasingly has become one of the popular technologies in classrooms; however, there are some shortcomings associated with this tool. For example, a research study found that only half of the public school teachers who had computers available in their schools used them for classroom teaching and learning (Smerdon et al., 2000). One reason is a number of teachers refuse to use this technology, and many instructors have not been provided training in the use of this technology (Muir, 2007). Also, in this study, secondary mathematics teachers indicated that they did not use computers because they lacked experience and access to educational software, lacked knowledge about appropriate ways to use computers to enhance mathematics learning, and lacked professional training in using computers in mathematics instruction (Manoucherhri, 1999). Moreover, Weaver (2002) has shown that many school teachers have difficulty using technology in their classrooms. Furthermore, Forgasz (2006) has stated the top four barriers for not using computers in the classrooms: 1. access to computers 2. the need for professional development 3. lack of technical support or outdated equipment 4. lack of time to set up computers, acquiring basic skills, and lack of time preparing for the lessons. Lowther, Ross and Mossrison (2003) have discovered that the use of technology becomes beneficial when teachers have mastered the skills in learning how well they could use this technology in the classrooms. Schacter and Fagnano (1999) have stated that inclusion of this technology solely based on its efficiency should not be the determining factor in utilizing this technology in the classrooms. One determining factor should be the degree to which a lesson requires the use of this technology. In some concepts, the use of computer technology is essential, and in other situations its use may not enhance learning. Also, the use of one type of technology in some situations is more effective than another type of computer technology.

Wiles and Bondi (2002) have stated that technology helps students in more creative ways thus it will produce smarter learners. They also mentioned that the use of technology helps create a student-centered environment, in which students are actively involved in learning mathematics. The National Council of Teachers of Mathematics (2000) has stated technology as one of six principles of mathematics learning. Manouchehri (1999) found that computers help students in exploration of mathematical concepts, facilitate learners' growth of mathematical understanding and increase students' mathematical problem solving. Alagic (2003)

discovered that use of technology can help in several ways: integrate and connect mathematical concepts, use multiple concept representations, and connect mathematics to real world problems. O' Callaghan (1998) compared an algebra class which used computers with a traditional classroom. The author found that in computer-instructed classrooms, students learned a deeper understanding of mathematical concepts and children were able to better interpret, model and translate the concepts. Cates (2005) found that among older children, computer- assisted instruction was more effective in helping them than the younger children. Suh and Moyer (2007) also discovered that children were better able to understand algebratic relationships by using virtual manipulatives and improve their ability in translating their understanding in multiple representation. In a study, Hubbard (2000) used tutorial software to help students in learning mathematics, and the author discovered that students' mathematics skills increased by 25% while their problem solving abilities had an improvement of 100%. The researcher also indicated that students who used this software were twice as likely to earn better grades in geometry classes offered at their schools, and there was an increase in the number of students enrolled in Algebra II classes.

Effects of Computers on Achievement

Research studies have discovered that when computers are utilized in a classroom, learners will have an increase in mathematics achievement. Sadiq (2008) designed a game called Super Tangram which helped students learn about geometric transformations such as reflection and symmetry. The researcher discovered that children significantly improved their knowledge of geometric transformation. Wenglinsky (1999) examined the National Assessment of Educational Progress (NAEP) data and investigated the relationship between computer use and student mathematics achievement. The findings were mixed but showed that math achievement improved when computers were used to address higher order thinking such as problem solving. Kulik & Kulik (1991) showed that computer-based instruction helps students of all ages. Kulik (2003) summarized the results of eight meta-analyses which covered 61 studies published after 1990. The median effect size for studies using computer tutorials was 0.59, which indicated learners who received computer-assisted tutorials performed in the 72^{nd} percentile while students who received traditional instruction achieved in the 59^{th} percentile. In a study, Mendicino and Heffernan (2007) investigated three teaching environments: traditional teaching with no computers, computer-assisted environment, and using computers with interactive and dialogue features. The researcher found the learners in the latter two environments outperformed the former one. Moreover, students who used interactive computers outperformed learners with only computer-assisted instruction, which involved no dialogue or interactions. Furthermore, Mahmood (2006) examined four classes of developmental college math courses, of which two classes used computer assisted technology, and the other two classes did not use this technology. The study discovered that students in the classrooms with computer-aided instruction significantly outperformed learners without the aid of this technology on the Texas Education Higher Assessment (THEA) practice test, which is required for college entrance. The researchers, O' Dwyer and Keiman (2007), selected 213 students who were enrolled an online algebra I class and another 207 eighth and ninth grade children who were registered in traditional classes, discovered that students with online algebra classes outperformed students in of traditional classes.

Negative Effects of Computer Technology

Several studies have shown that the use of computer-assisted technology has not helped student learning, and it may be even detrimental to children. Wilfred (2008) found that students in traditional classes who did not use computers had significantly higher scores than the group who were assisted with computers in mathematics classes. Another study found when a mathematics software game was investigated for its effectiveness, it failed to significantly improve student mathematics learning (Neimeyer, 2006). Atkins (2005) used 542 students who were sixth, seventh, and eighth graders, and the study which spanned for three years, 2001-2003 showed that the students in the experimental group who used a computer-assisted integrated system, called the accelerated math, did not outperform the group who did not have access to this technology. Cates (2005) found that peer group instruction with no access to computers was more effective than the instruction which used computers in the classrooms. Moreover, Patrick (2001) mentioned that there were no significant differences in scores on the final exams between students who used computers along with lecture and children who had no access to this technology in their classrooms. Furthermore, another study found that students who used computer generated problems in their learning did not outperform students in traditional classrooms (Patrick, 2001). Kodippili and Searatne (2008) also investigated a similar study and found the ineffective use of technology. In addition, Anggrist and Lavy (2002) found that the use of computers on fourth graders resulted in a significant decrease in learning mathematics. Finally, a study stated that students' problem solving skills did not improve when they utilized computer technology as an instructional resource (Fuchs et al., 2006).

Gender

Several studies have investigated whether the female and male student performances are impacted differently when an instruction is assisted by the use of computer technology. Olusi (2008) compared the performance of female and male high school students and discovered that female students performed higher than the male students when using computers in their classrooms. It also showed both genders outperformed students in the control groups who had no access to computers (Olusi, 2008). A study by Vale and Leder (2004) examined the gender effect and discovered that male students believed that the use of computer technology had a major impact on their mathematics achievement. Nonetheless, the female students stated that they did not believe computers had a major impact in their learning of mathematics. Boys also indicated that they believed they could better relate their experiences with this technology. Moreover, another study found that male students felt computers were more useful in their learning than the female students (Volkmann & Van Eck, 2001). In a survey study in Australia, boys felt more confidence in learning mathematics when using computers, and they felt that they were more skillful in using this technology (Meredyth et al., 1999). Kim and Chang (2007) mentioned that the computer effect on learning was less beneficial for female students than male students. Wilfred (2008) investigated the effects of computer technology in algebra classes on female and male students and found no significant differences between male and female students.

Learning Styles

The use of computer-applied technology in classrooms helps students who have different learning styles. Computers can be used to individualize learning to a particular student based on his or her learning ability, and this technology allows students to receive immediate feedback. It also provides students with immediate reinforcement, and it motivates their learning experience. Furthermore, it regulates learning, and it tailors to a student's rate of learning (Xin, 1999).

The use of computers creates an environment that increases student control over learning, and research has shown that when students have control over learning, they tend to better succeed (Shyu & Brown, 1992). Other studies have shown that computers help increase children's achievement through control over learning which is a mediating factor (Van Merrienbore et al., 2002; Chen & Macredie, 2002). Moreover, a study has indicated this control factor not only increases student capability in solving problems, it will also help children better diagnose mathematical problems in future situations they encounter (Van Gog et al, 2005).

Minority Group Students

Studies have shown that the use of computers can facilitate learning for special students such as at-risk children, lower-performing learners, students from low-income families, and students with ADHD and Down's syndrome. A research study has documented that fourth grade students with ADHD improved their performances in problem solving when they used computer softwares in their schools. The study also showed children were more engaged in math activities. Moreover, students with access to computers behaved better than students in classes without the computer-assisted instruction (Mautone, et al., 2005). Ortega-Tudela and Gomez-Ariza (2006) have investigated the importance of using computer technology for Down's syndrome children. Their study discovered that when children tested on a pre- and post mathematics test, the results showed that Down's syndrome students who used computers outperformed those children with only paper-pencil method of learning. Page (2002) discovered that computer technology also helped special education children. In the study, the author used a software named *courseware program,* which determined weaknesses and strengths of students when encounter solving mathematical problems. Mouza (2008) stated that low-income children benefit from the use of the laptop as a supplemental tool in teaching mathematics. The study also discovered students were more engaged in mathematics activities, and there was an increase in interaction among students. Moreover, Mendicino and Heffernan (2007) have stated that the lower 25th percentile of the students benefited from the use of technology while the use of this tool had minimal effects on the higher top 25th percentile of the students.

Method

Participants

Six classes of freshman algebra I students were selected. Three classes were assigned in the control group while the other three classes were placed in the experimental group. There were 65 students in the experimental group and 62 students in the control group.

Procedures

The selection of these classes was based on students' mathematics scores from the previous term in order to make sure that these two groups were not significantly different with regard to their abilities. Therefore, the researcher analyzed scores of students from the previous term by using an independent pair t-test. The two groups were taught by the same teacher who was also the researcher of this study. During the last 20 minutes of the class, the teacher distributed daily worksheets to students in the control group. In the experimental group, students used computer assisted software which randomly selected problems related to the lesson taught. The software had tutorial features which students could use as resource material in helping them choose the correct answers. In both groups, the teacher was constantly walking in the class and helping students when students asked for help. The teacher collected students' work from both groups. At the end of the treatment, both groups took the same test, and their scores were analyzed in order to determine whether significant differences existed between them. Also, the researcher compared the lower-performing students' scores in both groups. Lower-performing students are defined as those who received a score of 70 or lower on the final exam.

Survey

At the end of the treatment both groups of students were given a survey by Sherman and Fennema (1977) in order to find their attitudes toward mathematics.

Exam

At the end of the treatment, both groups took an identical exam.

Results

Quantitative Analysis

The investigator examined whether the computer-assisted instruction was as effective as traditional teaching where computers are not used. The results show that the computer-aided instruction is not as effective as the traditional teaching. The mean score on the final exam for the experimental students is 77.33, and for the control group, 75.21. It also shows the mean score of the experimental group is 2.22 higher than the control group. The results do not show the use of this technology is more effective in helping students learn mathematics than traditional classrooms. Moreover, the independent t-test found the alpha level (p) of .24, meaning that the treatment did significantly affect student learning. The effect size of

this study was .08, indicating no significant differences between two groups with respect to the use of computer technology.

Table 1: The Mean Scores on the Final Exam for all Students in Both Groups

Experimental Group	**(n=65)**	**Control Group**	**(62)**	**ES**
M	SD	M	SD	
77.33	11.34	75.21	13.23	.08
Note. ES=Effect Size				

Table 2 shows how lower-performing students performed in both groups. It shows that lower-performing students in the experimental group who incorporated technology in their learning outperformed students in the control group who had no access with this technology. The mean of the experimental group was 73.28 and the control group was 65.13 with a mean difference of 8.15. The Independent t-test indicates that the treatment group significantly had higher scores on the exam than the control group because the *p* value is .027 which is less than the alpha level of .05. The effect size for this test is .31, indicating a moderate significant effect between the two groups with respect to the use of computer technology in classrooms.

Table 2: The Mean Scores of Final Exam for Low-performing Students in Both Experimental and the Control Groups

Experimental Group	**(n=65)**	**Control Group**	**(62)**	**ES**
M	SD	M	SD	
73.28	11.56	65.13	13.46	.31
Note. ES=Effect Size				

Table 3. shows whether the attitudes of students toward mathematics for both groups were significantly different. In the experimental group, the attitudes of the students increased from 3.84 to 3.41 while for the control group, the mean scores decreased from 3.51 to 3.47, which essentially remained constant. Therefore, this study indicates that computer use has helped increase student attitudes towards mathematics.

Table 3: The Mean for Pre-and Posttest Student Means from the Survey from the MANOVA

Experimental Group	**(n=65)**	**Control Group**	**(n=62)**	
Pretest	Posttest	Pretest	Posttest	*p*
3.41	3.84	3.51	3.47	.02
P is the level of significance at 0.05				

Qualitative Analysis

Qualitative data of this study support the quantitative results. The teacher interviewed gave additional insight to the improvement of lower-performing student in the experimental group in contrast to students in the control group:

> "Lower-performing students in the experimental group were more actively involved in the lesson; they seem to be less bored and distracted. They were very excited and anxious on working the problems when using computers. I observed less discipline problems with these students. One student asked me if I could allow them to use computers every day. It seems that fewer hall pass I issued for students to go to bathroom, which may indicate their interest in the use of this technology in the classroom. Some of the lower-performing students felt more confident because they helped higher- performing students how to use computer."

With regard to higher-achieving students in both control and experimental groups, the teacher had the following observation:

> "I definitely saw some of the higher-achieving students were more interested and excited about the use of computer in the classroom; however, I did not notice as much as excitement as the lower achieving students."

With regard to the use of technology in the classroom, the students also documented similar observations:

"I was more actively involved in solving the problems."
"I liked it; the use of technology in our math class."
"Solving problems on the computers was more fun."
"The class was more exciting."
"I was less distracted."
"I like computers."
"I like to get the answers from computer, and not to ask my teacher because I'm shy ."

However, students in the control groups had different observations:

"I liked it because I really like working with dictionaries."
"The class was boring."
"I faked paying attention to teacher."

The statements mentioned above by students supported the findings from quantitative analysis that there was an improvement in student achievement.

Conclusion

The results of this study were based on the examination of three research questions. First, the study found that lower-performing students in the experimental group who used computers in their learning outperformed learners with no access with this tool in their classrooms.

However, when including all students in each group, the study found that there were no significant differences in math achievement between the two groups. Second, the study also found that in the experimental group, student attitudes toward mathematics were significantly higher than students in the control group. This result supports a research by Ke (2008) who found student attitudes toward mathematics significantly improved when they used computer technology in their classrooms. The teacher and students' interviews showed that students felt they were more active in learning mathematics in contrast with the traditional classroom where the use of this technology was absent. The researcher of this study believes that one reason that higher performing students in the experimental group did not outperform students in the other group is that the content of the classroom activities in the computer-aided instruction was not challenging for these students. Vygoysky has stated for leaning to occur, students should be in the proximal zone of development, meaning that the content of a lesson should not be too easy or too difficult for them to understand. Therefore, the researcher should have included more challenging items on the computer-aided instruction. The implications of the results from this study indicate that mathematics teachers should be aware of the importance of computer-assisted technology as an essential tool for lower-performing students in mathematics classes. As the literature review of studies have discovered, the use of computers could be more effective for some mathematical concepts than others, so teachers need to be informed of when to utilize this technology. This researcher who has been a previous teacher has observed that when a teacher uses computers in the classroom, students tend to be more willing to learn mathematics, thereby increasing students' participation in classroom activities.

References

Alagic, M. (2003). Technology in mathematics education: Conceptual orientation. *Journal of Computers in Mathematics and Science teaching, 22*(4), 381-399.

Angrist, J. & Victor L, V. (2002). New evidence on classroom computers and pupil learning. *Economic Journal Royal Economic Society, 112*(482), 735-765.

Arbuckle, W. (2005). *Conceptual understanding in a computer-assisted Algebra 1 classroom.* University of Oklahoma, Unpublished Dissertation (AAT 3203318).

Atkins, J. (2005). *The association between the use of Accelerated Math and students' math achievement* . Unpublished Dissertation (AAT 3305586).

Cates, G. L. (2005). Effects of peer versus computer-assisted drill on mathematics responses rates. *Psychology in the Schools*, *56*(2), 42(6), 637-646.

Chen, S. Y., & Macredie, R. D. (2002). Cognitive styles and hypermedia navigation: Development of a learning model. *Journal of the American Society for Information Science and Technology, 53*(1), 3–15.

Duncombe, W., & Lukemeyer, A., Yinger, J. (2008). The no child left behind act: Have federal funds have been left behind. *Public Finance Review, 36*(4), 381-407.

Forgasz, H. (2006). Factors that encourage or inhibit *Computer* Use for Secondary Mathematics Teaching. *The Journal of Computers in Mathematics and Science Teaching, 25*(1), 77-93.

Fuchs, L. S.; Fuchs, D; Hamlet, C. L. (2006). The Effects of Computer-Assisted Instruction on Number Combination Skill in At-Risk First Graders. *Journal of Learning Disabilities, 39(5)*, 467-75.

Hubbard, L. (2000). Technology-based math curriculum. *The Journal*, 28(3), 80-84.

Ke, F. (2008). A case study of *computer* gaming for math: Engaged learning from gameplay. *Computers & Education* 51(4), 1609-20.

Kim, S., & Chang, M. (2007). *The Differential Effects of Computer Use on Academic Performance of Students from Immigrant and Gender Groups: Implications on Multimedia Enabled Education.* Paper presented at Multimedia Workshops. Retrieved *April, 12, 2009 from: http://www.apera08.nie.edu.sg/proceedings/1.25.pdf.*

Kodippili, A. & Searatne, D. (2008). Is computer-generated interactive mathematics homework more effective than traditional instructor-graded. *British Journal of Educational Technology, 39*(5), 928-932.

Kulik, J. A. and Kulik, C.-L. C. (1987) Review of recent literature on computer-based instruction. *Contemporary Education Review*, 12, 222-230.

Kulik, C. & Kulik, J. (1991) Effectiveness of computer-based instruction: An updated analysis. *Computers in Human Behavior 7*(1-2): 75-94.

Kulik, J. A. (2003) *Effects of Using Instructional Technology in Elementary and Secondary Schools: What Controlled Evaluation Studies Say* (No. P10446.001). Arlington, VA.: SRI International.

Lowther, D. L., Ross, S. M., & Morrison, G. M. (2003). When each one has one: The influence on teaching strategies and student achievement of using laptops in the classrooms. *Educational technology Research and Development, 5*(13), 23-44.

Mahmood, J. (2006). *Examining the mathematics performance of developmental mathematics students when computer-assisted instruction is combined with traditional strategies.* Unpublished Dissertation (AAT 3251891).

Manouchehri, A. (1999). Computers and school mathematics reform implications for math teacher educators. *Journal of Computers in Mathematics and Science Teaching*, *18*(1), 31-48.

Martin, M.O., Mullis, I.V.S., & Foy, P., Olson, J.F., Erberber, E., Preuschoff, C., & Galia, J. (2008). *TIMSS 2007 international science report: Findings from IEA's Trends in International Mathematics and Science Study at the fourth and eighth grades*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Mautone, J., DuPaul, G., Jilendra, A. (2005). The effect of computer-assisted instruction on the matics performance and classroom behavior of children with ADHD. *Journal of Attention Disorders, 9*(10, 301-312.

Mendicino, M., & Heffernan, N. (2007). Comparing the learning from intelligent tutoring systems, non-intelligent computer- based versions, and traditional classroom instruction. *Journal of Interactive Learning Research.* http://nth.wpi.edu/pubs_and_grants/papers/journals/MendicinoSubmitted.doc

Meredyth, D., Russell, N., Blackwood, L., Thomas, J., & Wise, P. (1999). *Real time: Computers, change and schooling*. Canberra: Department of Education, Training, and Youth Affairs. Retrieved April 17, 2009, from http://www.dest.gov.au/archive/schools/Publications/1999/realtime.pdf

Mouza, C. (2008). Learning with Laptops: Implementation and Outcomes in an Urban, Under-Privileged School *Journal of Research on Technology in Education, 40(4)*, 447-472.

Muir, M. (2007). technology and student learning. Retrieved April, 4, 2009 from http://www.nmsa.org/portals/0/pdf/research/Research_Summaries/Technology_Learning.pdf

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Center for Education Statistics (NCES, 2007). Retrieved March, 17, 2009, from http://nces.ed.gov/pubs2000/2000102A.pdf

Neimeyer, S. (2006). *An examination of the effects of computer-assisted educational ames on student achievement*. Unpublished dissertation (AAT 1437979). University of Houston-Clear Lake.

O' Callaghan, B. (1998). Computer intensive algebra on students' conceptual knowledge of functions. *Journal for Research in Mathematics Education*, 29, 21-40.

O'Dwyer, L., C., Keiman, G. (2007). A Study of the Effectiveness of the Louisiana Algebra I Online Course. *Journal of Research on Technology in Education, 39*(3)*,* 289-306.

Olusi, F. L. (2008). Using *Computer* to Solve *Mathematics* by Junior Secondary School Students in Edo State Nigeria. *College Student Journal,* 42(3), 748-55.

Ortega-Tudela, J. M.. & Gomez-Ariza, C. J. (2006). Computer-assisted teaching and mathematical learning in down syndrome children. *Journal of Computer Assisted Learning, 22* (4), 298-307.

Page, M. S. (2002). Technology-enriched classrooms: Effects on students of low socioeconomic status. *Journal on Technology in Education, 34,* 389-409.

Patrick, K. D. (2001). A comparison of computer-mediated and lecture classes in developmental mathematics. *Research and Teaching in Developmental Education, 18*(1), 32-40.

Sadiq, K. (2008). From Play to Thoughtful Learning: A design strategy to engage c*hildren* with mathematical representations. T*he Journal of Computers in Mathematics and Science Teaching, 27(1)*, 55-101.

Schacter, J. & Fagnano, C. (1999). Does computer technology improve student learning and achievement? How, when, under what conditions? *Journal of Educational Computing Research, 20*(4), 329-343.

Sealy, C. (2006). Technology is a tool. *NCTM News Bulletin*, 3.

Sherman, J., & Fennema, E. (1977). The study of mathematics by high school girls and boys: Related variables. *American Educational Research Journal, 14,* 159-168.

Shyu, H.-Y., & Brown, S. W. (1992). Learner control versus program control in interactive videodisc instruction: What are the effects in procedural learning? *International Journal of Instructional Media, 19*(2), 85–96.

Smerdon, B., Cronen, S., Lanahan, L., Anderson, J., lannotti, N., Angeles, J., & Greene, B. (2000). *Teachers' tools for the 21st century: A report on teachers' use of technology.* Washington, DC: U.S. Department of Education.

Suh, J., Moyer, P. S. (2007). Developing Students' Representational Fluency Using Virtual and Physical Algebra Balances**.** *The Journal of Computers in Mathematics and Science Teaching,* 26(2).

Vale, C. M., & Leder, G. C. (2004). Student views of computer-based mathematics in the middle years: Does gender make a difference? *Educational Studies in Mathematics, 56*(2), 312-326.

Van Gog, T., Ericsson, K. A., Rikers, J. P., & Paas, F. (2005). Instructional design for advanced learners: Establishing connections between the theoretical frameworks of cognitive load and deliberate practice. *Educational Technology Research and Design, 53*(3), 73–81.

Van Merrienboer, J. J. G., Schuurman, J. G., de Croock, M. B. M., & Paas, F. G. W. C. (2002). Redirecting learners' attention during training: Effects on cognitive load, transfer test performance and training efficiency. *Learning and Instruction, 12*, 11–37.

Volman, M. & Van Eck, E. (2001). Gender equity and information technology in education. The second decade. *Review of Educational Research*, *71*(4), 613-631.

Weaver, G. (2002). An examination of the National Educational Longitudinal Study (NELS: 88) database to probe the correlation between computer use in school and improvement in test scores. *Journal of Science Education and Technology,* 9, 121-133.

Wenglinsky, H. (1999). Does it compute? The relationship between educational technology and student achievement in mathematics. Princeton, New Jersey: Policy Information Center.

Wilfred, M. (2008). *Comparison between computer assisted instruction and traditional method instruction as applied to teaching algebra to urban high school students.* Unpublished dissertation (AAT 3324192).

Wiles, J. & Bondi, J. (2002). Curriculum development: *A guide to practice (6* th *ed .).*Upper saddle River, NJ: Pearson.

Xin, J. F. (1999). Computer-assisted cooperative learning in integrated classrooms for students with and without disabilities. *Information Technology in Childhood Education,* 61-78.

About the Author

Dr. Hosin Shirvani
I'm an assistant professor at the University of Texas-Pan American. Previously I was a high school mathematics teacher for 15 years. My area of research is mathematics learning. I would also like to know the most effective strategy teaching mathematics to special education students.