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The Effects of Teacher Mediation on Kindergarten Students' Computer-Assisted
Mathematics Learning

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Abstract

The purpose of this study was to examine the effects of teacher mediation on the mathematics learning of kindergarten students in a computer-assisted learning environment. A sample of 26 students was randomly selected and assigned into experimental and control groups. The experimental group was mediated by a teacher during the computer-assisted learning activity. The control group received no teacher mediation. Data were collected for both groups for activity enjoyment and mathematics learning experience at the end of 6 weeks. Data were analyzed using independent t-tests at a .05 level of significance. The results indicated a significant difference between experimental and control groups on levels of activity enjoyment. The experimental group showed higher levels of enjoyment compared to the control group. No significant difference was found in mathematics learning between the experimental and control group. The results on mathematics learning were not congruent with literature review. Further research is recommended.

Review of the Literature

Research on the Effectiveness of Computer-Assisted Instruction

The use of computers in the early childhood classrooms has become commonplace in recent years. With the advent of the relatively low-cost, personal microcomputer in the late 1970s, computer-assisted instruction moved from the college campus all the way to the elementary school. Subsequently, research results regarding the effectiveness of computer-assisted learning have been mixed. Early research touted the usefulness of the computer technology in classrooms (Kulik, 1998); however, other studies indicated that computers may not be useful in enhancing student learning and cognitive development (Salomon, 2000; Healy, 1998). Little research examined the context, situations, and relationships that might be necessary for effective computer technology usage in the classroom.

Some researchers have suggested that it is no longer necessary to question whether the use of technology is appropriate in early childhood education (Clements & Swaminathan, 1995). Early research results suggested that computers enhanced social interaction among young children (Muller & Perlmutter, 1985; Natasi, Clements & Battista, 1990). More recently, computer-based instruction has been credited with enhanced development of reading skills and other learning development situations (Clements & Sarama, 2003). However, closer examination of empirical results yields conflicting evidence.

The relationship between computer-administered instruction and phonological awareness was examined by Foster, Erickson, Foster, Brinkman & Torgesen (1994). In their study, the *Daisyquest* software program was examined in two experiments. In the first experiment, one group of 12 kindergarten students was instructed using the *Daisyquest* software. A second, control group of 12 received no *Daisyquest* training. Subjects from the trained group showed significantly greater gains in two different tests of phonological awareness. However, in the second experiment, with a more completely developed version of the software, the results could not be duplicated. The trained group demonstrated higher mean levels of phonological awareness, but the differences from the control group were not statistically significant.

Use of the computer has been linked to greater enjoyment of learning activities. Tancock & Segedy (2004) studied the effects of technology on responses to texts. In their study, 2nd grade students were divided into two groups. The treatment group read and performed research from six online texts, while the control group performed research from printed versions of the same texts. After the reading assignments, subjects responded to questions about their reading with pencil and paper activities or with technology-based activities. Additionally, the students filled out surveys about how much they enjoyed the activities and their perceptions of how much they learned. The control group outscored the treatment group on reading comprehension on five of the six stories. With regard to the survey questions the treatment group reported greater enjoyment of the texts and perceived higher levels of learning for all six texts. The authors concluded that the treatment subjects' time may have been taken up with experimentation with the computer, resulting in lower comprehension.

Brabbam, Murray & Bowden (2006) investigated whether differences in literacy learning would result from teachers using different emphases when reading alphabet books aloud. Half of the teachers emphasized word meanings and the other half emphasized phonemes. Additionally, within each treatment, the teachers used centers where the children used an alphabet book (Dr. Suess's ABC) with either an audiotape of the book or a CD-ROM over a period of four weeks.   Subjects for the study were 152 kindergarten children from 12 different classes and teachers in the southeastern United States. Ten different alphabet books were read by the teachers. Dependent measures included: vocabulary; letter name knowledge; phonetic cue reading; and phoneme identities. Pre- and post-test measures were taken on each of the dependent variables. Again, the results were mixed. The data analysis showed significant main effects for both reading emphasis and media type and a significant interaction between reading emphasis and media type for the phoneme identity variable. However, within the phoneme identity condition practice with audiotape rather than CD-ROMs produced statistically significant score improvement. The findings of the study suggested that at least some literacy skills were improved by reading alphabet books with a phoneme emphasis while using audiotapes rather than CD-ROMs for practicing skills.

The effects of computer technology on the academic achievement of African American children have been examined (Judge, 2005). They studied the impact of access to and use of computer technology on the academic achievement of 1,601 African American kindergarten and 1st grade students.   The results indicated that access to computer technology at home and in the classroom was positively correlated to academic achievement for both grades. Frequency of use of software related to literacy and math

was positively correlated with academic achievement in kindergarten; however, the correlation between frequency of use of literacy and math software and academic achievement was not significant for 1st graders.

A recent study examined fun, usability, and learning with regard to educational software (Sim, MacFarlane, & Read, 2006). Subjects were 25 English primary school children ages seven and eight. Three science software packages were evaluated using pre- and post-tests to measure learning effects. The subjects were surveyed to assess usability and fun of each package. The findings of this study indicated that while the students found the packages usable and fun, there were no significant learning effects. Significantly, for one software package, the average post-test score was lower than the average pre-test score.

A review of six research studies conducted over the last twenty years regarding the use of computers by young children found that the body of evidence was inconclusive (Campbell, Milbourne, Dugan & Wilcox, 2006). The authors cited both the small number of studies and design deficiencies as possible causes for the inconclusive results.

Others have taken a more critical view of the appropriate role of computer technology in the classroom. Cordes & Miller (2000) cited several hazards to computer usage in childhood, including risks to physical health, emotional and social development, moral development, and creativity and intellectual development. Regarding intellectual risks, they cited stunted imaginations, impoverished language and literacy skills, poor concentration, intolerance for the hard work of learning, plagiarism, and distraction from meaning. They criticized the quality of research into the effects of computers on academic achievement, noting that much of the evidence cited was anecdotal. Also, of

particular note with regard to the motivation for this study, the authors suggested that research had not established the ways that technology might be used to improve education, nor had consensus developed regarding preferred methods of pedagogy.

Samaras (1996) suggested that the interaction of teachers and computers was important to learning outcomes. He stated:

> Computers cannot revolutionize the way students are taught unless teachers examine how they teach without computers. Without teacher support, students in computer contexts may experience an unsustained locus of control through a trial-and-error process that is devoid of task conceptualization. (p.133)

Further, he noted that the teacher/student interaction remained largely unexamined.

Some writers have suggested the need for guided interaction with the computer. Plowman and Stephen (2005) identified several ways that teachers provided guidance to young students interacting with the computer such as: explaining how to use software; suggesting alternative actions; moving children to an appropriate level of difficulty; offering remedial help; and, sharing pleasure in features such as animation.

Similarly, Nir-Gal & Klein (2004) held that stronger interpersonal ties between students and teachers were necessary for computer technology to be an effective educational tool. They suggested that the theory of mediated learning provided a basis for describing and planning the teacher/student interaction.

Mediated Learning Theory

Mediated learning experiences were first described and enumerated by Feuerstein (1979). He defined the mediated learning experience as follows:

> Mediated learning experience is the interactional processes between the developing human organism and an experienced, intentional adult who, by interposing himself between the child and external sources of stimulation, mediates the world to the child by framing, selecting, focusing, and feeding back environmental experiences in such a way as to produce in him appropriate learning sets and habits. (p.71)

Therefore, mediated learning occurred with children when the learning environment was altered by the intervention of an adult (teacher). The modifications adapted the environment to the learner's needs, interests, and abilities and were a direct result of the adult mediation.

Rand and Reichenberg (2001) discussed mediated learning and distinguished between teaching as action and teaching as interaction. The differences related to didactic approach. Teaching as action reflected the teacher's role as transmitter of information and the students' role as a more passive recipient of the information. The authors contrasted this approach with teaching as interaction, which they essentially considered to be linked to mediated learning. They described teaching as interaction as emphasizing the mutuality, reciprocity, and partnership of the teaching/learning situation. They held that teaching as interaction was more demanding of both parties because it required nearly continuous adaptation.

Mediated learning theory has received wide acceptance. Writers have described uses of mediated learning theory in contexts other than education. For example, Falik (2001) stated that the theory was useful in counseling and therapeutic processes, emphasizing the nature of the interactive process that occurs between counselor and the person being counseled, whether adult or child.

Mediated learning theory was expanded to define five elements of mediated learning experiences. They were: 1) focusing-intentional acts of an adult directed toward affecting the child's perception or behavior, for example: selecting, exaggerating, accentuating, scheduling, grouping, sequencing, or pacing stimuli; 2) affecting-an adult behavior that expresses verbal or nonverbal excitement or appreciation related to objects and/or animals or concepts and ideas; 3) expanding-an adult's behavior directed toward the expansion of a child's cognitive awareness beyond that necessary to satisfy the immediate need causing the interaction; 4) encouraging-any verbal or nonverbal behavior that expresses satisfaction with a child's behavior, such as saying "good job" or "wonderful" or clapping hands or smiling upon the child's completion of an assigned task; and, 5) regulating-adult behavior that models, demonstrates or suggests the specific requirements of a task, such as suggesting that food may be hot and needs to be cooled by blowing on it before the child puts it in his/her mouth or telling a child to wash slowly so as not to get soap in her/his eyes (Klein, 1996; Klein and Alony, 1993).

Research on Teacher Mediated Computer-Assisted Learning

Significant research into the effectiveness of teacher mediated learning has been reported. Much of this research has examined teacher mediation in a computer-assisted learning environment. In an early study, Miller & Emihovich (1986) examined the effect of teacher mediation on preschool children's comprehension monitoring abilities while using *Logo* software and other computer-assisted instruction. The results of this small-sample study showed significant positive pre- to post-test effects of the teacher mediation during a referential communication task. The researchers noted that definitive conclusions were not appropriate because differences in the computer conditions (*Logo* versus other computer-assisted instruction) confounded the results to some extent. However, they also concluded that the use of mediated teaching techniques was a critical variable by which children learn and called for additional research in this area.

Researchers have studied the use of computer programs that mimic certain aspects of mediated learning. Klein & Nir-Gal (1992) attempted to improve four-to-six year-old children's analogical thinking through the use of a computer program designed to incorporate several features of human mediation. 120 kindergarten students were assigned to one of two treatment groups or one control group. One treatment group received teacher mediation and the other received software mediation designed with the human-like mediation features. The control group received no meditation. The results showed that both treatment groups scored significantly higher on several cognitive measures than the control group. No significant differences were seen on any cognitive measures between the treatment groups.

The effects of mediation in environments other than the classroom have been examined. Klein & Alony (1993) studied the effects of maternal mediating behaviors on the young children. Sixty-eight women and their four-year-old children participated in the study. The experimental group of mothers was given training on five variables of mediated learning. The control group mothers received only information regarding childhood development milestones. Several dependent measures of cognitive ability were identified and measured. The experimental group children scored higher on several cognitive measures. Maternal mediation was found to be significantly related to specific child behaviors as well as the cognitive measures.

The effects of mediation on students considered at-risk for academic failure was studied by Powell, Aeby & Carpenter-Aeby (2003). They studied the effects of teacher facilitation on math and science outcomes for disruptive students using computer-assisted instruction. The *SucessMakers* math and science software package was used with 215 students assigned to an alternative school because of disruptive behavior and considered to be at-risk for academic failure. The computer-assisted instruction was provided with teacher facilitation to the treatment group and without teacher facilitation to the control group. The students were eighth, ninth and tenth graders. The teacher-facilitated group attained significantly higher grade point averages over the grading period studied.

The effects of different types of adult assistance (mediation) on the cognitive performance of young children using computers were examined by Nir-Gal & Klein (2004). 150 Israeli kindergarten students from middle-class families were randomly selected to participate in the study. The students were divided into six treatment groups by (a) type of guidance (mediation, accompaniment, and no assistance); and (b) type of

software program (*Logo* or *Game* software). Teachers were trained on how to mediate the students based on mediated learning theory. The actual teacher intervention with the students lasted 17 weeks. Various and multiple measures of the dependent variables were measured after the treatment period and analyzed. The major findings of this study supported the first research hypothesis; that is, that young children who used computers in the presence of a mediating adult learned more than children using the computer without mediation or with limited assistance. The mediation group scored higher on all the cognitive measures. The second hypothesis was not supported. No differences were found between groups on the performance of the children using the *Logo* or the *Games* software.

Teacher mediation has been associated with positive social interaction. Lau, Higgins, Geifer, Hong, & Miller (2005) examined the impact of teacher mediation on social interactions of preschool children engaged in computer activities. Their study included children with and without learning disabilities. The 36 participants were divided into two groups. The treatment group received teacher mediation during computer activities while the control group did not receive mediation. Children with and without disabilities from the teacher-mediated (treatment) group exhibited a greater number of positive social interactions and demonstrated more effective social behaviors than children in the control group.

Conclusion

Computer-assisted learning has become commonplace in the elementary education classroom. Research regarding the effectiveness of computer-assisted learning has produced mixed results that suggested there may be more than just computer usage affecting the learning situation. In more recent years, mediated learning theory has been suggested as a basis for improving the computer learning environment and a substantial body of research investigating this relationship has been produced. The results of this research generally have suggested that teacher mediation may be a significant factor in increasing the effectiveness of computer-assisted learning.   Research to date has not examined the effectiveness of teacher mediation in the kindergarten classroom on specific computer-assisted learning outcomes. This study attempted to provide evidence regarding this deficiency by examining the effects of teacher mediation on mathematics learning outcomes in a computer-assisted learning environment.

Methodology and Procedures

The results of previous research indicated that while computer technology may not be conducive to enhanced student learning, outcomes may be improved by the use of teacher mediation in the student/technology interaction. These mediation effects have not been studied in a specific computer-assisted environment in the kindergarten classroom. The purpose of this study was to examine the effects of teacher mediation on the mathematics learning of kindergarten students in a computer-assisted learning environment.

This study was conducted at one elementary school in northeast Tennessee. The grades at the school included kindergarten through fifth grade. Approximately 493 students attended the school. Of that number, 81% were Caucasian, 15% were African American, 3% were Hispanic and 1% per of Asian American. Approximately 46% of the students qualified for free or reduced-price lunches, suggesting that a significant percentage of the children were economically disadvantaged.

The sample consisted of 26 students randomly selected from three kindergarten classes at the school. Of the 26 subjects, 14 or 53.8% were male and 12 or 46.2% were female. The sample comprised of 84.5% Caucasian, 11.5% African American, and 4.0% Hispanic. The percentage qualifying for reduced or free lunches could not be determined. Data were collected using the Success Makers Software.

Extent of learning was assessed using the Math Concepts and Achievement Progress Report included with the *SuccessMakers* software. SuccessMaker is a widely used software package designed to teach and assess math, reading, and other skills in elementary and secondary education. Periodically, progress reports are generated

reflecting students progression from one achievement level to the next. The results of this test measured a skill level from zero to 12 for each student subject at a given point in time. Student enjoyment of the computer learning experience was measured using a Smilyometer (Sim, MacFarlane & Read, 2005). Students were presented with five simple "smiley"-type faces that ranged from a strong frown to a strong smile and asked to indicate which picture (face) best represented how much they enjoyed the activity.

Procedures

Prior to commencement of the study, permission of the school principal to conduct the study was requested. After permission was given, a random sample of 26 students from three kindergarten classes was selected. The students were then randomly assigned to two classes. One class served as experimental while the other served as the control. Each class contained 13 students. The experimental group received the mediation treatment while the control group did not.

Each class participated in weekly 30-45 minute sessions using the *SuccessMakers* software for six weeks. The control group received no mediation by the researcher or any other teacher, while the treatment group's sessions were mediated by the researcher. The mediation was adapted from four of the five defined elements of mediated learning experiences (Klein, 1996; Klein and Alony, 1993). The mediating behaviors used were: 1) focusing-intentional acts of the researcher that were directed toward affecting the child's perception or behavior, for example: selecting, exaggerating, accentuating, scheduling, grouping, sequencing, or pacing stimuli to direct the child's attention to the task; 2) affecting- verbal or nonverbal excitement or appreciation expressed by the

researcher related to mathematical concepts and ideas; 3) encouraging- verbal or

nonverbal researcher behavior that expressed satisfaction with a child's behavior, such as

saying "good job" or "wonderful" or clapping hands or smiling upon the child's

completion of an assigned task; and, 4) regulating- researcher behavior that modeled,

demonstrated or suggested the specific requirements of a task, such as suggesting that one

task much be completed before another.

At the end of the six-week treatment period, a *SucessMakers* Progress Report was

generated for each subject. Data for the experimental group and control group were

compared. Additionally, at the conclusion of the treatment period, each subject was

asked to rate how much fun (enjoyment) they had while engaged in the computer-assisted

learning sessions. Each student was asked to use the Smileyometer and select a face to

indicate how much they had enjoyed the experience. The faces were ranked from one

(strong frown) to five (strong smile) and the mean response for each group calculated.

Data for both groups were compared.

Results

Research Questions

Two research questions were used to guide the analysis of data:

Research Question 1: Does teacher mediation improve kindergarteners'

mathematics learning outcomes in a computer-assisted environment?

Research Question 2: Is there a difference between the students taught using

teacher mediation and those not taught with teacher mediation on enjoyment of learning

activities?

Each research question was followed by a research hypothesis. Both research questions were analyzed using independent t-tests. The results of research question 1 did not yield significant results. Independent t-test for research question 2 yielded significant results (t (24), =2.410, P<.05). Therefore, the null hypothesis was rejected. The results are displayed in Table 1.

Table 1

Independent t-test for Experimental and Control Groups on Enjoyment of Computer Activities

Group	m	sd	df	t-value	p(one-tailed sig)
Experimental	4.7692	.59914	24	2.410	.012
Control	3.9231	1.11516	-	-	-

Discussion

Two research questions were addressed in this research. The first research question focused on the effects of teacher mediation on kindergarten students' computer assisted mathematics learning. The research question asked "Is there a difference in kindergartener's math performance when teacher mediations were used and when they were not?"

The results indicated that there was not a significant difference between the experimental and control groups, and, therefore, the null hypothesis that there was no difference in the means of the groups' learning effect was retained (t(24)= -1.022, p>.05).

The findings regarding learning experience run counter to expectations based on the review of the existing literature which consistently reports positive effects when teacher mediation is used in a variety of situations. Although the causes of this finding cannot be investigated in this study, several possible explanations can be suggested.

First, subsequent investigation into the scoring system used by *SuccessMakers* suggests that the software may have systematically produced measurement inconsistencies with the higher-performing students. Kindergarten students begin using the software in the initial placement mode. In this mode, students take 30 question tests. The program will increase or decrease the level depending on the number of questions answered correctly. This may result in a lower score than they had previously achieved. For example, a student who failed to stay in level 2 would automatically begin at a lower level. Review of the individual scores shows that three of the higher-scoring students in the mediated group actually had lower scores reported on the post-test. The score decrease resulted in the learning experience mean of the mediated group being lower than the mean of the control group. The data to investigate this issue further are not available; therefore, the possibility of measurement error for these higher-performing students cannot be eliminated.

Second, lack of training in the mediation techniques may have resulted in ineffective student/teacher interaction. In previous research, the mediators generally had been trained by experienced mediators prior to commencing mediation efforts. Because this type of training was unavailable, the teacher in this research reviewed the existing mediation literature to ascertain the appropriate techniques to use.

Third, students believed they were learning when in reality the interaction with the teacher gave them a false sense of success that could not be maintained when they had to use the computer without mediation. The students completed the post-test without any assistance. They may have come to depend on the teacher's mediation efforts to assist them and, in fact, had not learned as much as had been indicated.

Fourth, the mediator was known to and popular with the students. Although enjoyable, the teacher/student interaction may have distracted the students and resulted in lower levels of learning. This would be consistent with the findings of previous research. Distraction of younger students has been cited as a possible cause of lower levels of learning in connection with a learning activity where the students reported significantly higher levels of enjoyment (Tancock & Segedy, 2004; Sim, MacFarlane & Read, 2005).

The second research question was stated as follows:

Is there a difference in the enjoyment of computer-assisted activities when teacher mediation was used and when it was not?

The data obtained on enjoyment from the Smileyometer instrument was used to assess level of enjoyment of the learning activity. To test if the group means were significantly different, an independent t-test was conducted. As expected, the results indicated that there was a significant difference between the experimental and control groups, and, therefore, the null hypothesis was rejected ($t(24)=2.410$, $p<.05$). The experimental group reported significantly higher levels of enjoyment of the activity. Students tended to have more freedom to ask questions from the mediator creating a better environment to explore learning without fear. As a result of this, they appeared to

enjoy tasks/activities more than the control group. The findings regarding student enjoyment were consistent with previous research findings that suggest that students find computer-based learning activities enjoyable.

Conclusions

The purpose of this study was to examine the effects of teacher mediation on the mathematics learning of kindergarten students in a computer-assisted learning environment. Data regarding the learning effect of teacher mediation and student enjoyment of the activity were collected and analyzed. The results indicated that while students receiving teacher mediation during the computer learning activity enjoyed the activity significantly more than those not receiving mediation, there was no statistically significant difference in learning effect between that group and a control group that did not receive teacher mediation. In fact, while the mean difference in learning was not statistically significant, the control group learning effect mean was higher than the mean for the experimental group.

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