Comparsion of Multimedia Computer Assisted Instruction, Traditional Instruction and Combined Instruction on Learning the Skills of Long Jump

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Abstract

The purpose of this study was to determine the effect of multimedia computer - assisted instruction (MCAI), traditional instruction (TI), and combined instruction (CI) methods on learning the long jump event. Forty-eight middle school students of seventh and eighth grade were randomly assigned into three teaching method groups: MCAI, TI and CI. Each group received ten 45-min periods of instruction divided into 4 sections: a) 5 min warm-up, b) 15-min instructional time c) 15-min main practice time and d) 10-min cool dawn and review. Students took pre-, post-, and retention skill test and written test covering rules and concepts of the event. Two-way analysis of variances (ANOVA), with repeated measures on the last factor, were conducted to determine effect of method groups (MCAI, TI, CI) and measures (pre-test, post-test, 1-week retention test) on knowledge and skill test. Post-test results indicated no significant differences between the groups concerning the written test. Nevertheless, the mean skill test scores of the TI and CI groups were significantly greater than MCAI group. Retention test results showed that groups retained the knowledge and skill learning. However, the mean skill test score of the MCAI group was significantly lower than the TI and CI groups. Conclusively, the CI method tended to be the most effective for cognitive learning and skill development.

KEY WORDS: INSTRUCTIONAL TECHNOLOGY; MULTIMEDIA SOFTWARE; TRADITIONAL INSTRUCTION; COGNITIVE LEARNING; MOTOR LEARNING; LONG JUMP.

Introduction

During the past three decades, a large number of meta-analyses have systematically examined the effects of technology on student outcomes. Overall, these meta-analyses have documented the positive effects of educational technology on student achievement (Schacter, 2001; Sivin-Kachala, 1998; Wenglinsky, 1998). These studies, reviews, and meta-analyses, however, typically look at different aspects or types of technology. Furthermore, this knowledge base has not really provided information on how to appropriately integrate and use technology in schools and classrooms. In addition, recent improvements regarding the quality and quantity of technology in schools suggest that technology in schools today is dramatically different from the technology that used in schools several years ago. This rapid growth and improvement in technology exceeds current knowledge of how to effectively use technology in schools (Allen, 2001) and suggests that the impact of technology is different today than it was in the past.

Several recent meta-analyses have focused on specific aspects of technology. Blok, Oostdam, Otter, and Overmaat (2002), for example, examined the effectiveness of computer-assisted instruction (CAI) programs in supporting beginning readers. Their review included 42 studies from 1990 onward, and they found the corrected overall effect size estimate was .19. Their findings were similar to earlier meta-analyses by Kulik and Kulik (1991) and Bangert-Drowns (1993), which also examined the effects of CAI and found it to have positive but small effects. Wiemeyer, (2003) reviewed nine meta-analyses of earlier and different multimedia issues and suggested that multimedia learning can be more effective and efficient than traditional learning. But this effect depends on many factors like the features of the learners, the teachers, the learning stuff, the type of learning, the features of the study, etc. Further, a meta-analysis of 167 studies (Bernard, Abrami, Lou, Borokhovski, Wade, Wozney, Wallet, Fiset and Binru Huang, 2004) concluded that a very weak learning advantage for multimedia in empirical studies is based on uncontrolled instructional methods.

Richardson, (1997) compared student perceptions and learning outcomes of computer-assisted instruction against those of traditional didactic lectures. He found that computer laboratory instruction enhanced learning outcomes in medical physiology despite student perceptions to the contrary. Other recent meta-analyses in technology have examined topics such as the effectiveness of interactive distance education (Cavanaugh, 2001), computer-assisted instruction in science education (Bayraktar, 2002), and computer-based instructional simulation (Lee, 1999). Furthermore, other recent meta-analyses have examined the effects of computer-assisted instruction on student achievement in differing science and demographic areas (Christmann & Badgett, 1999), microcomputer-based computer-assisted instruction within differing subject areas (Christmann, Badgett, & Lucking, 1997), and the effectiveness of computer-assisted instruction on the academic achievement of secondary students (Christmann, Lucking, & Badgett, 1997).

One area in which there have not been many meta-analyses and systematic reviews of the research is how teaching and learning with multimedia technology impacts student outcomes in physical education. This area is important because some studies have found that multimedia technology can change teachers' pedagogic practices from a teacher-centered or teacher-directed model to a more student-centered classroom where students work cooperatively, have opportunities to make choices, and play an active role in their learning. Antoniou, Derri, Kioumourtzoglou, and Mouroutsos (2003), for example, examined the effect of multimedia computer assisted instruction (MCAI), traditional instruction (TI), and combined instruction (CI) on learning rule violations in basketball by university physical education students. Written test results indicated that students in all groups improved their knowledge of rule violations but only those in the TI and CI groups retained this knowledge. Also, the researchers found that TI group showed significantly greater retention than the MCAI group both in the written test and in total performance. In another study that examined changes in physical activity and nutritional patterns of high school physical education students as a result of multimedia technology, Everhart, Harshaw, Everhart, Kernodle, and Stubblefield (2002) found that the year-long multimedia intervention did not affect physical activity or nutritional patterns of students significantly.

Vernadakis, Zetou, Antoniou, and Kioumourtzoglou (2004) reported that MCAI is a functional method in teaching the skill of basketball shooting to middle school students, aged 12 – 14 year old and is as effective as traditional teaching method. The results of this study showed that there were no significant differences between the MCAI, TI and CI groups with regards to the knowledge and skill test. These findings are similar to prior studies that found MCAI to be as effective as TI in teaching tennis (Kerns 1989) and golf rules and strategies (Adams, Kandt, Throgmartin, and Waldrop 1991). Although these individual studies have examined how multimedia technology impacts learning in the cognitive domain, little is known about how this intervention impacts student outcomes in the motor domain.

The effectiveness of physical education software on student outcomes has yet to be determined especially through the use of the newer multimedia programs. Therefore, the purpose of this study was to compare three different instructional methods by means of the knowledge and skill test scores, obtained from three groups of middle school students. The tests assessed the learning of the long jump event. More specifically, the study was conducted to explore the following four research questions:

1. Should one or more items on knowledge test be deleted or revised to obtain a better measure of long jump skill?
2. Do students, on average, report differently on knowledge and skill test using the MCAI, the TI and the CI teaching approaches?
3. Do students, on average, report differently on knowledge and skill test for the pre-test, post-test and 1-week retention test measurements?
4. Do the differences in means for knowledge and skill test between the MCAI, TI and CI teaching method groups vary between the pre-test, post-test and 1-week retention test measurements?

Methods

Participants

To obtain permission for conducting the field experiment, the researchers contacted local middle schools in a northern city of Greece. All school principals expressed their willingness to participate. The private school Dellasal of Thessaloniki, having an indoor gymnasium and essential network equipment, was chosen for the experiment. Forty-eight (n=48) middle school students (25 boys and 23 girls) of seventh and eighth grade, 12-14 years of age (M=13, S.D. =1.01), selected for this study by random sampling method, enrolled in the long jump course. Participants were randomly assigned to one of the three different teaching methods: MCAI (9 boys and 7 girls), TI (8 boys and 8 girls) and CI (8 boys and 8 girls) creating three independent groups of 16 students. All participants had no formal training on learning the long jump event. Prior to group assignments, participants were orientated to the purpose of the study and participant requirements. Following the orientation, informed consent form was obtained from each participant. The students should have returned the informed consent form signed by his/her parent or guardian in order to participate in the research.

Instrumentation

Hardware

Ten 1.8 MHz Pentium IIII class computers equipped with a 17-inch color monitor, CD-ROM, soundcard and small headset, running Windows 2000 professional were used.

Software

The “Asymetrix Multimedia Toolbook” authoring system was used to provide an alternative method of disseminating information to the traditional method approach. This is one of the best-known multimedia software production environments for the Windows platform. A multimedia CD-ROM was produced to administer experimental events including 114 screens; 4 screens were introductory, 1 was main menu, 32 were information, 26 were practice, 40 were feedback, and 11 were help. Material for the multimedia application was taken from a long jump coaching textbook (Jacoby and Fraley, 1995) and modified for this study. The application consisted of three sections: a) history, rules and skill fundamentals b) skill techniques, and c) skill exercises. Two choices menus, one for the termination of the program and one for help, were also included at the bottom of the screen and were always available. The help menu contained a description of the active picture-buttons and suggestions for the program use. The program started with an introductive video of International Association of Athletics Federation (IAAF). The main menu with four active picture-buttons which serve as links to the other screens of the program followed.

The first major section addressed basic knowledge of long jump pertaining to vocabulary used, history of the event, rules, area dimensions, names, and skill fundamentals. The skill techniques section introduced basic techniques of long jump to show jumpers how to avoid common technical flaws. A step by step instructional format that was accompanied by an exceptional graphic simulation depicting proper form of long jump at different stage was included in these sections. A discussion of possible errors, what causes these errors, and what may be done to correct these errors was provided in the description of the skill. When the user had seen enough of the long jump skill, he could supplement short quizzes (multiple choices, true/false) regarding the technique and concepts that were presented. The skill exercises section introduced basic long jump exercises for practical work in terms and levels that were appropriated for beginning long jumper. The exercises section uses video footage of professional long jumpers performing each long jump drill. Each drill was demonstrated several times and was shown from different angles. Audio was used to explain each action and give execution cues to help focus the attention of the user. Common errors, corrections and suggested standards of performance were presented.

Each section included different relevant material like text, sound, pictures, animated vector images, graphics and video. Users were responsible for their own learning, interacting with the material as opposed to passively receiving the information. The interest of the user was thus maintained throughout since they were forced to make choices and were provided with feedback as to decisions made ensuring misconceptions and user problems were answered immediately. Users navigated through the sections by activating the links that appeared on each screen. At the end of the program, a screen with the title of the program, the names of the author and the institution were presented.

Systematic Instructional Design (SID) concept was used to design the multimedia learning material. SID comprises three main phases: a) analysis and planning, b) development and production, and c) evaluation, application and revision, which are discussed in the Appentix.

Knowledge Test

A knowledge test was developed to determine students’ achievement on cognitive learning for the skill of the long jump. A table of specifications was developed to reflect the interrelationship between the identified course content and the levels of learning. Based on these specifications a 20-item, multiple-choice test was constructed. Each test item had five options in order to reduce the probability of guessing. The test construction was based on the linear model which required that the test scores were obtained by summing the number of correct answers with equal weighting over the items. The questions were written on the basis of the learning objectives outlined in the Ministry of Education's Long Jump Curriculum Guideline.

After the questions were constructed as explained above, a panel of experts in long jump teaching and coaching were used to evaluate and judge the content validity of the test instrument. This group reviewed the test items and established whether each item measured the target skill. Every time a set of changes was made, the questionnaire was reviewed again by the consultants, until the instrument was deemed adequate.

The revised version of the knowledge test consisted of a 13-item multiple-choice test. Questions included in the knowledge test fell into one of the following categories: a) eight skill concepts and b) five general rules associated with the skill. A pilot study was performed to access item difficulty and clarity of questions. Questions were scored one point for a right answer and no point for a wrong answer.

Skill Test

No measuring instrument was available to measure the amount of skill development of long jump event but it was not really needed because the results of competitions reflect achievement (Strand & Wilson, 1993). Therefore, a skill test was constructed based on guidelines from a well-established assessing sport skills textbook (Strand & Wilson, 1993). The skill test was developed with two main considerations in mind. First, the test administrators should have been able to administer the test within one class period. Secondly, the testing procedures should have been at a level of understanding not above that of the students. Long Jump area, 30 metre tape measure, scoring equipment and two testers to act as judge and recorder/scorer respectively were needed for the successful completion of the test.

Before the test begins, it was stressed to the students that landing on the feet was important for safety. During the test, the jumper was positioned 6 to 9 metres behind the scratch line. On the "ready, go" signal, the jumper began his approach and accelerated to reach maximum speed at takeoff while gauging his stride to arrive with one foot on and as near as possible to the edge of the board. The jumper used the tuck technique in flight, in which the knees was brought up toward the chest and the legs was brought together for landing. Each student received two warm-up jumps (trials) prior to the actual testing. Students received three test trials. All students performed the first trial before any of the students performed the second trial.

The length of the jump was measured from the edge of the takeoff board to the nearest mark in the landing area surface made by any part of the body. The recorder was responsible to record the results of jumper's effort. The judge was responsible for measuring point of jump and for determining illegal trial in the pit. Trial should be counted as a failure: a) if the jumper started his leap with any part of his foot in front of the scratch line, b) if he run up without jumping or in the act of jumping and c) if he left the landing area after a completed jump and walked back through the landing area. Failed efforts had to be repeated. The test score was obtained by summing the three test trials and dividing that number by the number of the test trials.

Procedure

A pilot study was followed to determine the reliability and validity of the knowledge test. Participants consisted of 24 seventh and eighth grade middle school students. This population was chosen to keep the pilot study similar to the main study regarding participant's age. The method of instruction used for the pilot study was TI, which incorporated a direct style of teaching such as lectures, demonstrations, teacher questions and student questions. Participants were given two 45-minute class periods of instruction and review concerning the long jump event. This was done to take into account the fact that participants had not received formal instruction pertaining to this particular skill for almost one year. The knowledge test was administered on the 3-day on a paper and pencil test consisting of 13 multiple-choice questions. The instruction took place in an indoor gymnasium in order to avoid complications associated with weather conditions.

After the pilot study, a main study was conducted to compare the scores obtained by 48 seventh and eighth grade middle school students for a skill test and a knowledge test. The experimental design consisted of a pre-test, a post-test and an 1-week retetion test for the three of the independent groups. The knowledge test was administered on the 1-day and the skill test was given on the 2-day to measure participant's baseline performance on the selected athletic event. Procedures for the knowledge test were the same as the pilot test. There were three fewer questions, reducing the number of questions to ten.

On the 3-day, ten computers were set up in a blocked-off hallway adjacent to the gymnasium. Each computer had a long jump skill CD-ROM created by the researchers. Computers were separated as much as possible to create individual workstations. Before the experiment started, the MCAI and CI groups were given a 45-minute introductory session on how to use the multimedia application program prepared for this study. Then the physical education instructor gave a 45-minute lecture to all participants introducing the unit of long jump event. Instruction, practice, and testing for this study were held on ten separate and successive weeks. The groups met for 45-minute, 1 times each week in an indoor gymnasium.

The TI method incorporated a direct style of teaching including lectures, demonstrations, teacher questions and student questions. Participants in the TI group received a series of progressive skills, performed in drill format, accompanied by verbal feedback in the form of positive reinforcement. Students were given verbal instruction for 15-minute as well as 15-minute of practice time following the formal instruction time. They were allowed to work alone without a partner. The physical education instructor gave verbal instruction before every drill and knowledge performance every five trials during the 15-minute of practice time. There were 5-minute of warm-up at the beginning of the period and the remaining time of approximately 10-minute was for cool-down and review.

Participants in the MCAI group were allowed to work independently. The students were given 15-minute of computer time on a Pentium IIII computer. A multimedia program was developed for the purpose of this study, which was based on hypertext, graphics, animation, media and video. The MCAI program consisted of three sections, which corresponded precisely to theoretical and practical work. Students received 15-minute of physical practice time following the time spent on the computer. There were 5-minute of warm-up at the beginning of the period and the remaining time of approximately 10-minute was for cool down and review. The instructor was present for organization and management supervision only. No verbal or visual reinforcement of any kind was offered by the instructor.

The CI group followed the same procedure, while implementing both the multimedia program and the traditional instruction. In the first five weeks the students participated with the TI method group, and the remaining weeks with the MCAI method group. The theoretical and practice sessions consisted of the same instruction and exercises, which took place in the MCAI and the TI methods. Material for the three method groups was taken from a long jump coaching textbook (Jacoby and Fraley, 1995).

At the end of the treatment, the knowledge was given and the following day the skill test that previously served as a pre-test was given to students as a post-test. One week later, the same procedure was repeated on the 1-week retention test to measure the level of retention in the selected athletic event. During the experiment, the participants in the three groups had no access to multimedia or to traditional learning environments beyond what was utilized as part of the experiment.

Design

Due to practical limitation, a field experiment instead of a laboratory experiment was conducted to test the research questions. The experiment was a factorial design with teaching method groups (MCAI, TI and CI) and repeated measurements (pre-test, post-test and 1-week retention test) as independent variables, and knowledge learning and skill learning performance as dependent variables.

Results

Homogeneity of variance and Sphericity was verified by the Box's *M* test, the Levene's test and the Mauchly's test (Green & Salkind, 2003). Initial differences between the three groups for the mean knowledge and skill test scores were tested using one-way analysis of variance. An item analysis using the responses of the pilot study was conducted to determine the difficulty rating and index of discrimination. In determining the internal consistency of the knowledge test, the alpha reliability method was used. Two-way analyses of variances (ANOVAs), with repeated measures on the last factor, were conducted to determine effect of method groups (MCAI, TI, CI) and measures (pre-test, post-test, 1-week retention test) on knowledge and skill test. We controlled for family wise error rate across these tests using Bonferroni approach, which means that the alpha level of significance was set to .025 (.05/2). Means and standard deviation for the MCAI, TI and the CI group in pre-test, post-test and 1-week retention test are presented on table 1, while results of each analysis are presented separately below.

Table 1. Means and standard deviations for pre-test, post-test and 1-week retention scores of the three groups on knowledge and skill tests.

	Group	N	Mean	Std. Deviation
Knowledge Pre-test	TI	16	3.43	1.19
	MCAI	16	3.69	1.25
	CI	16	3.94	1.57
Knowledge Post-test	TI	16	5.95	2.02
	MCAI	16	6.25	2.24
	CI	16	6.56	2.31

Knowledge 1-week retention test	TI	16	5.89	1.98
	MCAI	16	6.13	2.06
	CI	16	6.50	2.28
Skill Pre-test	TI	16	2.94	0.27
	MCAI	16	2.69	0.53
	CI	16	3.00	0.47
Skill Post-test	TI	16	3.42	0.27
	MCAI	16	2.91	0.53
	CI	16	3.59	0.48
Skill 1-week retention test	TI	16	3.37	0.28
	MCAI	16	2.84	0.53
	CI	16	3.55	0.48

Item Analysis

The pilot study knowledge test had a mean difficulty rating of 59%. When all items were analyzed, two questions, or 15.38% of the items, had unacceptable difficulty rating values. The utilization of a difficulty rating criterion of between 10% and 90% resulted in 84.61% of the items yielding an acceptable level of difficulty. The pilot study knowledge test had a mean index of discrimination of .36. When all items were analyzed, three questions, or 23.07% of the items yielded an unacceptable index of discrimination values. The acceptable value for index of discrimination was .20 or higher. Acceptable index of discrimination values were observed for 76.92% of the items. Finally one more question, or 7.69% of the items, had unacceptable index discrimination and difficulty rating values. As indicated by the information in table 2, three of the items (7, 12 & 13) were therefore deleted from the test for the main study.

Table 2. Summary of Item Analysis for pilot study knowledge test.

Questions	Index of discrimination	Difficulty rating	Results
1	.60	30%	Retained
2	.48	35%	Retained
3	.30	79%	Retained
4	.55	37%	Retained
5	.48	75%	Retained
6	.39	54%	Retained
7	.08	78%	Eliminated
8	.29	64%	Retained
9	.33	59%	Retained
10	.60	27%	Retained
11	.57	35%	Retained
12	.03	97%	Eliminated
13	.04	96%	Eliminated

Reliability Analysis

An alpha reliability coefficient .76 was computed based on the inter-item correlation coefficients of the pilot study knowledge test. According to Green, & Salkind (2003), the reliability coefficient should be at least .70 for the test to be considered reliable. Thus, the determination was made that the pilot knowledge test was a reliable measuring instrument.

Two-way Analyses of Variances (ANOVAs) with Repeated Measures

Knowledge Test

There were no significant initial differences between the three teaching method groups for the mean knowledge test scores, $F(2,45) = 1.696$, $p>.05$. Mauchly's test of Sphericity was significant so a lower-bound (=0.500) transformation for the degrees of freedom was applied. A significant main effect was noted for the time, $F(1,45) = 100.037$, $p<.001$ but not for the group, $F(2,45) = 1.453$, $p>.05$, while the interaction time X group was also not significant, $F(2,45) = .460$, $p>.05$.

Difference and repeated contrasts were conducted to follow up the significant time main effect. Differences in mean rating of knowledge test in TI group were significantly different between pre-test and post-test, $F(1,15) = 53.571$, $p<.001$ and between pre-test and 1-week retention test, $F(1,15) = 77.143$, $p<.001$. Differences in mean rating of knowledge test in MCAI group were significantly different between pre-test and post-test, $F(1,15) = 17.921$, $p<.001$ and between pre-test and 1-week retention test, $F(1,15) = 21.593$, $p<.001$. Finally differences in mean rating of knowledge test in CI group were significantly different between pre-test and post-test, $F(1,15) = 39.611$, $p<.001$ and between pre-test and 1-week retention test, $F(1,15) = 41.667$, $p<.001$. As shown in figure 1, the post-test and 1-week retention test knowledge scores were remarkably greater than pre-test knowledge scores for the three groups, while the difference between the post-test and 1-week retention test was not significant.

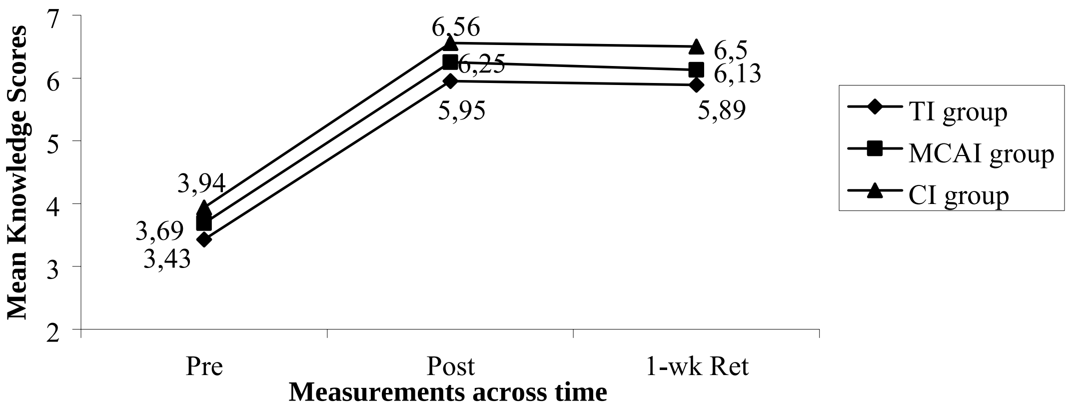

Figure 1. Performance of the three groups on all measurements across time of the Knowledge Test.

Skill Test

There were no significant initial differences between the three teaching method groups for the mean skill test scores, $F(2,45) = 2.37$, $p>.05$. Mauchly's test of Sphericity was significant so a lower-bound (=0.500) transformation for the degrees of freedom was applied. A significant main effect was noted for the time, $F(1,45) = 1986.27$, $p<.001$ and for the group, $F(2,45) = 7.30$, $p<.01$, while the interaction time X group was also significant, $F(2,45) = 149.45$, $p<.001$.

One-way analysis of variance (ANOVA) was conducted to follow up the significant interaction and assess differences among teaching method groups at each time period. Significant differences among the groups were noted in both post-test ($F(2,45) = 10.31$, $p<.001$) and 1-week retention test ($F(2,45) = 11.08$, $p<.001$). According to Scheffé pairwise comparisons, at post-test, the mean skill test scores for the MCAI group (M=2.91 SD=0.53) was significantly lower than mean skill test scores of the TI (M=3.42 SD=0.27) and CI groups (M=3.59 SD=0.48). Similarly, at 1-week retention test measure, the mean skill test scores for the MCAI group (*M*=2.84 *SD*=0.53) was significantly lower than mean skill test scores of the TI (*M*=3.37 *SD*=0.28) and CI groups (*M*=3.55 *SD*=0.48). As shown in figure 2, the difference in mean skill test scores was lower for the MCAI method group at post-test and 1-week retention test measures.

Finally, difference and repeated contrasts were conducted to follow up the significant time main effect. Differences in mean rating of skill test in TI group were significantly different between pre-test and post-test, $F(1,15) = 9.304$, $p<.001$ and between pre-test and 1-week retention test, $F(1,15) = 15.016$, $p<.001$. Differences in mean rating of skill test in MCAI group were significantly different between pre-test and post-test, $F(1,15) = 23.710$, $p<.05$ and between pre-test and 1-week retention test, $F(1,15) = 19.286$, $p<.001$. Finally differences in mean rating of skill test in CI group were significantly different between pre-test and post-test, $F(1,15) = 24.771$, $p<.001$ and between pre-test and 1-week retention test, $F(1,15) = 25.312$, $p<.001$. As shown in figure 2, the post-test and 1-week retention test skill scores were remarkably greater than pre-test skill scores for the three groups, while the difference between the post-test and 1-week retention test was not significant.

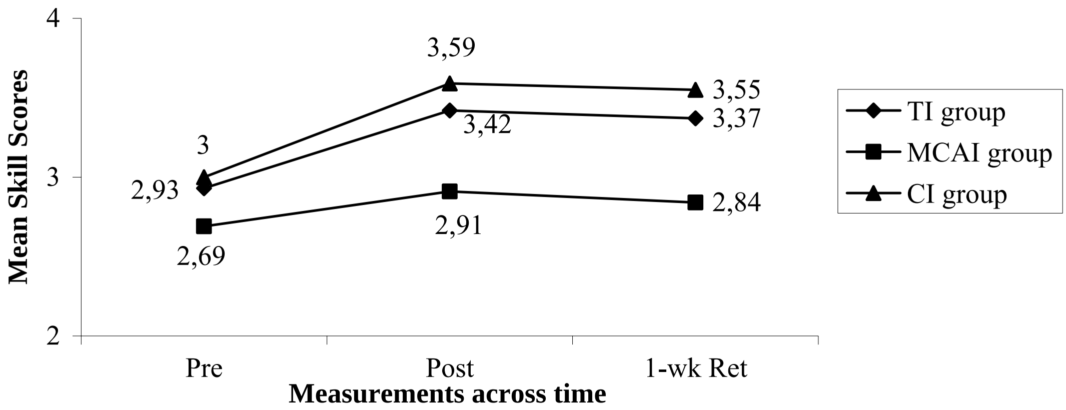

Figure 2. Performance of the three groups on all measurements across time of the skill test.

Discussion

The present study was designed to examine differences that may occur when individuals learn a motor skill under different instructional teaching methods and replicated previous findings by showing differential performance dependent on teaching methods. With regard to the knowledge and skill test, all groups improved their cognitive learning and skill development in long jump event, after instruction. Post-test results indicated no significant differences between the groups concerning the written test. Nevertheless, the mean skill test scores of the TI and CI groups were significantly greater than MCAI group. Retention test results showed that groups retained the knowledge and skill learning. However, the mean skill test score of the MCAI group was significantly lower than the TI and CI groups.

Comparison to the literature

The results from this study were parallel with the results reported in the literature. Some evidence suggests that the TI method is superior to the MCAI method while other evidence is contradictory. From a recent multimedia study on learning rule violations in basketball, Antoniou et al. (2003) found that university physical education students receiving lecture instruction performed significantly better than the MCAI group. In other literature reported, the MCAI method was found to be superior. Siskos, Antoniou, Papaioannou, and Laparidis (2005) found that MCAI was superior to traditional classroom teaching in the transmission of health-related fitness and nutrition knowledge. Also, others report no significant differences in a comparison of testing results between TI and MCAI methods. Vernadakis, Zetou, Avgerinos, Giannousi and Kioumourtzoglou (2006) compared three different instructional methods by means of the skill test scores, obtained from three groups of middle school students. The tests assessed the learning of the setting skill in volleyball. They reported equal improvement in learning with TI, MCAI and CI method. Furthermore, they conluded that the combined method of instruction tended to be the most effective for skill development. In earlier studies comparing the impact of MCAI and TI method, Adams, et al. (1991) and Kerns (1989) found no significant differences in scores of tests in golf and tennis rules.

Discussion possible shortcomings of the design

Evaluating the outcomes of the present research study, greater consideration needs to be given to those factors that might strongly affect students' learning. First, students were from one middle school of Thessaloniki. A larger and more diverse sample would provide a more stringent test for cognitive learning and skill development on a MCAI program. Additionally, the results reported in this study are based on a single MCAI program. This is a case-specificity problem. It is possible that a different type of MCAI package covering different content would yield different results.

Secondly, the age of students might be critical when it comes to learning independently. Since the participating students were all around 13 years of age when this study was conducted, they might not possess the learning skills that are needed in order to work independently using individual computers. Besides, research has also found that first-time users of computers are often overwhelmed by the vast amount of materials and information that can be presented by multimedia courseware (Renshaw and Taylor, 2000). These types of differences between the three groups, therefore, might be reflected in the students' post-test and 1-week retention test skill scores.

Third, no attempt was made to control possible differences in computer skills and multimedia experiences of the students or the effective learning time of the students' real engagement in multimedia learning. If these limitations have been controlled and the effective learning time had lasted longer, the researchers might have reported more precise results for the effectiveness of MCAI, TI, and CI methods on cognitive learning and skill development of the long jump event. For those reasons, further research may be needed to replicate this study.

Another consideration for the results includes time limitations on instruction and use of the multimedia program. With respect to time factors, participants who were in the TI group did not have to concern themselves with logging on to a multimedia computer program, navigating within that program and pacing their progress so as to remain within the 15-minute of practice time.

Finally, the TI group did not have to face the unknown instructional environment of computers, since elementary school students have experienced classroom instruction for roughly 6 years. The MCAI method, according to McKethan, Everhart, and Stubblefield (2000), has the disadvantage of requiring prior experience of the educational process from the user. In the present study the unknown instructional environment of computers did directly affect the improvement of motor learning in MCAI group.

Those limitations of the research learning environment may have significantly affected the experimental groups' ability to learn and to retain the cognitive and motor skill of the long jump event. However, it would be difficult to be certain, that the MCAI group would have been more successful than TI and CI groups on cognitive learning and skill development if the above limitations could have been eliminated. In that sense, these results indicate that students can be taught through the use of multiple effective teaching techniques. Multimedia programs have been generally successful especially when it has been used in connection with regular classroom instruction (Vernadakis et al., 2004).

Consequences for future research

In conclusion, multimedia programs can be utilized to enhance the effectiveness of teaching strategies or techniques in physical education classes. Computers can be used for the teaching of the cognitive aspects of sports such as rules and scoring procedures, and to allow teachers to have more time to spend with students' motor skills. However, these conclusions are limited for students aged 12 – 14 years old. More studies should be conducted to investigate the effect of MCAI in different ages and for various sport activities. Also, it is critical to continue researching into how students learn in different technological environments, since the researchers have only begun to explore the uses and practicality of MCAI.

Consequence for future practice

Education today is experiencing a variety of problems such as budget cuts and large class sizes, and teachers are being seriously affected by these problems. Teachers must find new and better ways to facilitate the learning of students. For example, physical education classes can be divided, one group working with software programs such as computer assisted instruction, while the other group can be at the gymnasium or at a teaching station, learning the motor skills involved in the sport. Teachers would have more engaged time with each student because the group would be small. Therefore, physical education teachers and teachers in general have to take full advantage of the new technology such as multimedia programs. It is of up most importance to educate teachers and provide them with opportunities to build new teaching strategies which incorporate the use of computer and advanced technologies.

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Appendix

Systematic Instructional Design (SID) concept was used to design the multimedia learning material. SID comprises three main phases: a) analysis and planning, b) development and production, and c) evaluation, application and revision, which are discussed in following paragraphs.

Phase 1: Analysis and planning

Learner characteristics is one of the most important factors effecting the design of multimedia learning material. Specifically, it seems necessary to examine the level of prior knowledge that the learners have on the subject. If the learner has prior knowledge, it is easier to integrate the new knowledge into the existing knowledge structure and decide on meaningful learning steps in the instructional tool. In addition, the age and maturity of the users are other important aspects to be considered. First, the users who participated in this study had no previous knowledge on the unit selected for the study. The students took an athletic course in the previous semester, but it did not include the selected units. Second, the researcher consulted four subject-matter experts (one university instructor and three physical education instructors) about the participants' age and maturity level and concluded that the unit selected for the study would be appropriate for this group of students.

The objectives of the unit covered in the instructional material were determined on the basis of the Ministry of Education's Long Jump Curriculum Guideline.

Content analysis was conducted and concepts, interrelated concepts, and procedures were determined on the basis of the objectives of the unit determined. Systematic relationships between the concepts were organized. A subject-matter expert evaluated the semantic relationships of the concepts determined. In the light of this evaluation, the semantic relationships between the concepts were reorganized.

Considering the characteristics of the users and unit, Ausubel's deductive learning strategy was adapted. First general and simple knowledge was provided, then detailed and specific knowledge.

Finally, the issues of knowledge organization and linking nodes to each other were managed. Hierarchical links were used in that material. First basic concepts, and then subordinate concepts related to the basic concepts were presented.

Phase 2: Development and production

Concept maps of the unit were constructed to ascertain interrelations between concepts determined in content analysis. That stage was important to show each node and links between the nodes.

Story boarding was the last step before the programming stage. Story boarding involves showing each navigation window on a page. Each window to be designed in this study was shown on a separate page. Active keys, the names of linked windows, links, text, visuals, video, sound, and graphics were also shown on that page.

“Asymetrix Multimedia Toolbook” authoring system was used for programming.

Phase 3: Evaluation, application and revision

After the material was developed, the researchers gave it to an instructional technology specialist, a subject-area expert, and three subject area teachers for evaluation. Researchers revised and improved the material according to the feedback received from those experts.