Computers & Education 62 (2013) 62–71

Contents lists available at SciVerse ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

The effects of computer-assisted instruction on the achievement, attitudes and retention of fourth grade mathematics students in North Cyprus

Olga Pilli [a,*], Meral Aksu [b]

[a] Eastern Mediterranean University, Computer and Instructional Technology Teacher Education, Faculty of Education, Gazimagusa, Cyprus
[b] Middle East Technical University, Faculty of Education, Ankara, Turkey

ARTICLE INFO

Article history:
Received 7 March 2012
Received in revised form
28 June 2012
Accepted 16 October 2012

Keywords:
Educational software
Computer-assisted instruction
Mathematics achievement
Retention
Attitude towards mathematics

ABSTRACT

The purpose of this study was to examine the effects of the educational software *Frizbi Mathematics 4* on 4th grade student's mathematics achievement, retention, attitudes toward mathematics and attitude toward computer assisted learning. Two groups (experimental and control) of students from the state primary school in Gazimagusa, North Cyprus were used in this study. The control group was taught using a lecture-based traditional instruction and experimental group was taught using educational software, namely *Frizbi Mathematics 4*. The control group consisted of 26 students while the experimental group consisted of 29 students. The groups were compared on achievement of mathematics, retention, and attitude toward mathematics and computer assisted learning. The study included three units, Multiplication of Natural Numbers, Division of Natural Numbers, and Fractions. Scores on achievement tests were collected three times; at the beginning of the study, immediately after the intervention, and 4 months later. The mathematics attitude scale and computer assisted learning attitude scale were administrated only two times; at the beginning of the study and immediately after the completion of the study. A series of ANOVAs for repeated measures revealed significant difference between the groups on the post achievement tests and attitude scales in favor of experimental group. However, statistically significant differences in favor of the treatment group, on the retention tests were attained on the multiplication and division units but not on fractions. The evidence indicates that *Frizbi Mathematics 4* for learning and teaching mathematics at the primary school level in North Cyprus is an effective tool.

1. Introduction

Computers have advanced greatly since their first commercial use in the 1960s. They have developed from expensive, cumbersome devices to powerful but affordable tools used in modern life for both professional and leisure activities. Their use in education has increased dramatically in recent years and now computers and related technologies are in most schools all over the world. Advances in technology are inevitably reflected in educational systems. In most developed countries education has been penetrated by Information Technologies (IT). Many teachers use computers and new technologies while teaching and many textbooks have included new technologies (Hicks & Holden, 2007). Most educators and researchers try to use these new technologies, and this integration has changed the nature, concepts and methods of work in each subject (Custer, 2000). For example, in mathematics, teaching and learning have changed with the use of technology (Hoyles & Lagrange, 2010, p. 494).

In the past, mathematics concepts were traditionally taught using abstract examples and words (Samuelsson, 2008). With the growth of computer technology in recent years, software use has been able to redefine and simulate mathematical concepts (Kebritchi, Hirumi & Bai, 2010). Through the use of electronic devices, many mathematical concepts become clearer and easier to understand which has been encouraging for primary school students. Giving students the chance to use computers offers them a practical and active learning experience which provides better understanding and concrete learning. Some computer-assisted instruction (CAI) types provide learning environments that engage students in creative tasks and problem solving that reflect real-world assumptions (Hoyles & Noss, 1992, p. 494; Kapa, 1999). For instance, students who have followed geometry instruction with computer-augmented activities have benefited more in

* Corresponding author. Tel.: +357 90 542 865 90 59 (mobile).
E-mail addresses: olga.pilli@emu.edu.tr (O. Pilli), aksume@metu.edu.tr (M. Aksu).

0360-1315/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.compedu.2012.10.010

terms of knowledge of geometry concepts than students who have received more traditional geometry instruction (Funkhouser, 2003). Computer-assisted instruction (CAI) is a narrower term and most often refers to the use of computers to present drill-and-practice, tutorials, or simulation activities offered either by themselves or as supplements to traditional, teacher directed instruction (Hicks & Holden, 2007). A study conducted by Baştürk (2005) also found that learning could be enhanced through the use of CAI. The term CAI used in this study refers to instruction that is carried out using the educational software *Frizbi Mathematics 4* to facilitate learning and teaching through individual student interaction with a computer.

Traditional Instruction (TI) refers the use of traditional teacher-centered methods and standard tools of mathematics in the classroom such as rulers, pencils, and paper to teach mathematics content. In the case of traditional methods in mathematics teaching, teachers usually provide instruction of mathematics concepts by using abstract examples and words. This way of teaching, which needs highly cognitive skills to assimilate the taught subject puts a lot of pressure on students leading them to lose their self-confidence which lowers their capacity for learning. Most mathematics content in primary education in North Cyprus is provided in a traditional manner. Lecturing and questioning are the most common teaching methods in most mathematics classrooms (Pesen, Odabaşı, & Bindar, 2000). Thus students encounter many difficulties in acquiring what is taught, and more importantly, this causes them to memorize most mathematical concepts without understanding (Cankoy & Tut, 2002). Although some innovative approaches were incorporated into the school curricula with the publication of a new "North Cyprus Education System" booklet in 2005, currently, traditional teaching techniques, such as lecturing, are commonly used in North Cyprus (Ministry of National Education and Culture, 2005). Similar to North Cyprus, students in Hong Kong mostly receive traditional instruction. In a study in Hong Kong, Mok, Johnson, Cheung, and Lee (2000) suggested the use of technology, such as graphics calculators, to eliminate problems in secondary school algebra where major teaching activities are conventional in style and do not provide sufficient opportunities for students to develop conceptual understanding. However, there has been no such scientific study in North Cyprus to investigate the integration of computers in education.

In the last two decades in developed countries the argument is no longer whether to integrate computers into educational systems but rather how computers should be used to gain more effective results (Hoyer, 2005; Lou, 2004; Zang, Watson & Banfield, 2007). Based on a number of studies (Ash, 2005; Funkhouser, 2003; Gürbüz & Birgin, 2012), it was hypothesized that the introduction of educational software into mathematics lessons could provide a viable alternative to enhance learning in mathematics lessons in North Cyprus. In order to understand the possible outcome of CAI on student's achievement in mathematics, attitudes toward mathematics and attitudes toward computer-assisted learning, the researcher of this study utilized the educational software, *Frizbi Mathematics 4*,as a supplementary tool in fourth grade mathematics lessons. There were four main research questions raised in this study:

1. Is there a significant difference between the achievement test scores of the students exposed to CAI via *Frizbi Mathematics 4* and those who were exposed to TI with textbook only?
2. Is there a significant difference between the mathematics attitude scale scores of the students exposed to CAI via *Frizbi Mathematics 4* and those who were exposed to TI with textbook only?
3. Is there a significant difference between the computer assisted learning attitude scale scores of the students exposed to CAI via *Frizbi Mathematics 4* and those who were exposed to TI with textbook only?
4. Is there a significant difference between the retention test scores of the students exposed to CAI via *Frizbi Mathematics 4* and those who were exposed to TI with textbook only?

2. Review of literature

Within the last twenty years, in spite of the view that there is great potential in the use of computer technologies for mathematics teaching purposes, many developed and most developing countries seem to have ignored this opportunity to improve learning practices. Although there have been many reports which support the necessity of the integration of computer technologies into mathematics teaching (NCETM, 2011; NCTM, 2012), the results of some of the studies have not been consistent with each other. Also, CAI studies have predominantly focused on a small number of countries.

2.1. CAI and achievement

Computer Assisted Instruction has been gaining acceptance as one of the technologies that can be used effectively in educational systems (Liu, 2008). Compared to traditional teaching methods such as lecture and discussion, CAI offers the important advantage of being able to adapt materials to the needs of each student (Gu, Fu & Tong, 2010). In this way, context can be varied to increase its meaningfulness for individuals (Ross & Anand, 1987). Kılıç (2007) compared three instructional approaches: traditional instruction versus computer-assisted cooperative learning versus cooperative learning method on teaching mathematics throughout one academic year with 67 fifth grade students. Results of the study revealed that the computer-assisted cooperative group's achievement and attitudes were significantly higher than those in the traditional and cooperative learning method groups (Kılıç, 2007). Christmann and Badgett (2000) investigated the academic achievement levels of students in a control group who had classes that used traditional methodology with those of students in an experimental group who had classes in which CAI was used as a supplement to traditional methodology. They compiled data from 26 studies and found an overall mean effect size of .127. Results of the study showed that when students were exposed to CAI, typical student achievement moved from the 50th percentile to the 55th percentile (Christmann & Badgett, 2000). In their study of mathematics for third grade students, Reimer and Mayer (2005) used virtual manipulation to investigate the effects of using several virtual manipulative computer applets to assess students' achievement and attitudes towards the fraction unit. Results of students' interviews and attitude surveys revealed that computer-based virtual manipulation helped students in the experimental group understand fractions better with the help of immediate and specific feedback. Additionally, Akoğlu's (2003) study indicated that programmed instruction with computer assisted instruction had an impact on fourth grade students' mathematics achievement on fractions. Rayne and Baggott (2004) provided the results of a meta-analysis of 40 comparative studies that compared the effectiveness of traditional instruction alone with a combination of