A PILOT STUDY USING TABLET COMPUTERS FOR TEACHING ADDITION TO THE FIRST GRADE STUDENTS

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Abstract

The purpose of this study is to investigate if tablet computers help improve primary school students’ mathematical achievements regarding addition. Our research compares the level of mathematical competence of the students taught using our tablet computers oriented learning method which specifically takes advantage of ‘Realistic Mathematics Education’ (RME) for the concept of addition, as opposed to traditional teaching methodology. The designed software consisted of several activities with and without the use of computers for addition. It was designed following the background of the RME theory. Moreover, we use the mathematical test based on TEMA-3 to explore the use of tablet computers in the primary classroom for teaching basic mathematical concepts. It is a task orientated test which attends to measure the level of mathematical competence developed for students of the first grade. The present study was a pilot research of quasi-experimental design with one experimental and one control groups. We found that the students who were taught with educational intervention based on tablet computers and RME had a significant improvement on their general mathematical achievement and addition in comparison to those taught using the traditional teaching method.

Keywords: Tablet Computers, Realistic Mathematics Education, Addition, First Grade Students.

1 INTRODUCTION

The innovations which have been occurring through recent decades in Information and Communications Technology (ICT) have awakened the interest of the educational community which in turn has felt the need to evolve in its theoretical areas and pedagogic practices. Especially the integration of ICT into primary education has become a high priority for everybody involved in the learning process. Educational researches suggest that the mathematical difficulties students encounter later are connected with insufficient development of mathematical thinking in the first classes of the primary school years [1], [2], [3]. These technologies can therefore play an essential role in achieving the objectives of the first grade curriculum in all sectors and subjects if supported by developmentally appropriate software applications [4]-[7] embedded in appropriate educational scenarios [8]-[10].

Recently, with the rapid insertion of smart mobile devices in the lives of young children in the form of mobile phones and tablets [11], [12], the debate and scientific research has extended to the use of these digital technologies in education [13]. A growing body of research indicates that tablets offer innovative opportunities and appreciable improvements in student mathematical achievement, even in preschool education [14], [15], [16], [17]. The ease of use, the suitability for ‘anytime and anywhere learning’ provided by tablets, creates a particularly friendly, creative and pleasant environment for children, which enhances the learning process [18], [19], [20], [21].

The software designed and the students’ activities developed and examined for the purposes of the current study were inspired by the framework of Realistic Mathematics Education (RME). RME is an active and constantly evolving theory of teaching and learning mathematics [22]. Indicative of this is the learning teaching trajectories with intermediate attainment targets which was first conducted for calculation with whole numbers in primary school and then extended to other subjects [23], [24]. In the whole trajectory of the RME teaching theory, three main characteristics of understanding mathematical concepts are involved:

- The first level, context-bound counting and calculating, implicates young students with problem situations, in which questions of comparisons or ‘how many’ questions are posed in a way to be meaningful for children, relative to their experiences and always inside a context.

- In the second level, object-bound counting and calculating, students should be able to face direct ‘how many’ questions and answer them. Attention is focused to quantification, where the involvement of numbers is immediate. As a result, questions should relate to distinctive objects.
or quantities such as ‘how many candles are there’ or ‘which tin has the most sweets in it.’ At this level students should be able to organize the way of counting objects using clear patterns, so as to avoid mistakes.

- In the third level, pure counting and calculating via symbolization, students do not need any more the natural presence of objects in order to count, but their “physical or mental representations”, like numbers, fingers, dots, lines, etc. In this way, counting ceases to be object-bound and is, instead, transferred to physical or mental representations of the objects. These representations can occupy very different levels of abstraction, including that of ‘pure’ arithmetical numbers.

Following the theoretical framework that blends together Realistic Mathematics Education (RME) and the use of ICT in primary school, we designed a new model referred to as the First Grade Tablet Addition Model (FGTAM).

Our study was based on the above mentioned international literature; we set out to investigate the following research question:

1. The first class students who will be taught mathematical concepts with educational intervention based on FGTAM will have a significant improvement on general mathematical knowledge in comparison to those taught using the traditional teaching method.

2. The first class students who will be taught addition with educational intervention based on FGTAM will have a significant improvement on addition in comparison to those taught using the traditional teaching method.

2 METHODOLOGY

The present pilot research was conducted in three phases. In the first and third phases, the pre-test and post-test were given to the students respectively. In the second phase, the teaching intervention was performed.

2.1 Subjects

The study was carried out during the 2016-17 school year in four public primary schools located in the city of Athens. It was an experimental research which compared the tablet computer teaching process to traditional teaching based on the first grade curriculum. The sample included 179 first graders consisting of 94 girls and 85 boys aged six to seven years old. There were two groups in the study, one control (n=86) and one experimental (n=93). In the control group there was not a computer available for the students to use. The classes in the experimental group had tablet computers available for daily use by children as part of the teaching procedure. For the uniformity of the survey, instructions were given to the teachers who taught in the experimental or control groups.

2.2 Educational Measures

In the first phase, the pre-test was given to the classes of the experimental and control groups at the end of February 2017 to isolate the effects of the treatment by looking for inherent inequities in the mathematical achievement potential of the two groups. The pre-test was a test based on the Test of Early Mathematics Ability third edition (TEMA-3) [25].

The TEMA-3 is a norm-referenced, reliable, and valid test of early mathematical ability that is appropriate for children of ages 3 years and 0 months through 8 years and 11 months. The form of TEMA-3 contains 72 items. The purposes of TEMA-3 are to: a) identify the children who are significantly behind or ahead of their peers in the development of mathematical thinking, b) identify specific strengths and weaknesses in mathematical thinking, c) suggest instructional practices appropriate for individual children, d) document children’s progress in learning arithmetic and e) serve as a measure in research projects. Also, one of the purposes for developing the TEMA-3 was to provide researchers with a statistical test that was based on current research and theories about mathematical thinking. In particular, TEMA-3’s availability would stimulate the study of mathematical thinking in young children [26].

Due to the young age of the students, explicit details were given to the students by the teacher for the pre-test. These were pencil-and-paper tasks in which the students were asked to select numbers
including: reading and writing numbers, verbal counting, enumeration, cardinality rule, produce sets, choosing the greater and the lesser number, addition (Fig. 1), subtraction and multiplication.

Each task had a grade that was computed from the student's answers. Scores were computed for each of the individual mathematical tasks based on the TEMA-3. On average, students will be able to complete the relevant portion of the given test in 30 to 40 minutes.

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Question 22

A) How many are 3 and 4 together?

3+4=
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*Figure 1. The child has to solve the problem.*

### 2.3 Instructional Intervention

In the second phase, the control group taught with traditional teaching according to the first grade curriculum. Group and individual activities were given to children every day. The experimental group covered the same material at roughly the same time according to the FGTAM procedure. The content of the four week syllabus of the FGTAM was divided into four levels.

At the beginning of the teaching intervention (zero level) has activities called ‘Up and Down’ which the students have to help ‘Alvin’ to go up and down with the elevator in order to find his friends apartments’ (Fig. 2). It was designed using Flash CS6 Professional Edition and presented with tablet computers in the classroom. Then the students painted some of their favourite characters of the activity.

*Figure 2. The student had to help ‘Alvin’ to go up and down with the elevator (zero level).*

The first level started with an activity which the students identified the main objects of an addition problem by counting objects. The teacher gave three candies to John. Then, Mary gave two candies to John and the teacher asked the children, “How many pieces of candy does John have now?” (Fig. 3). Finally, a computer activity took place with addition problems in which Alvin had in a super market (Fig. 4).
In the second level of the teaching procedure the objects were hidden. For instance, the teacher gave some coins to a student and hid them in his wallet. Then another student took some coins from the first student’s wallet. At the end the student had to construct the mathematical problem of the hidden objects. Finally, a software activity followed with hidden objects (Fig. 5).

In the last level of the teaching process, the students are separated into groups and played the game "Supermarket" (Fig. 6). One student was the buyer and the other was the employee of the supermarket. The buyer wanted to buy two things. The students knew how much money had the buyer and the cost of the first thing that he bought. The children had to find how much money the second product cost. Afterwards, there were computer activities where the children had to find the missing number of an addition problem (Fig. 7).
Similarly, during the third and final phase of the study, after the teaching intervention, the same test was given to all students in both the experimental and control groups as a post-test at the beginning of April 2017 to measure their improvement on general mathematical ability and addition.

3 RESULTS

Analysis of the data was carried out using the SPSS (ver. 19) statistical analysis computer program. An independent sample t-test was conducted. The independent variable had two levels: exposure to educational software with tablets (experimental group) and no exposure (control group).

The dependent variable was the student's pre-test score. The t-test for equality of means was significant ($t = 2.854$, $p = 0.005$), indicating significant differences initially, in mathematical achievement between the experimental and control groups. Though the experimental group had a mean score higher than the control group, the mean difference in the pre-test scores was 0.879. The results of this test are summarized in Table 1 and Table 2.

In order to determine if the performance of the experimental group is significant than the control group after the teaching intervention the analysis of ANCOVA on the students’ post-test scores was carried on. After adjusting the scores for mathematical achievements (TEMA-3) in the pre-test (covariate), the following results were obtained from the analysis of covariance (ANCOVA). A statistically significant main effect was found for type of intervention on the post-test scores for mathematical achievements, $F(1, 176) = 20.734$, $p = .001$, $\eta^2 = .105$; thus, after the teaching intervention the experimental group performed significantly higher in the post-test than the control group, as summarized in Table 3.

<table>
<thead>
<tr>
<th>Table 1. Group Statistics of pre test.</th>
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</thead>
<tbody>
<tr>
<td>Group</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>Experimental</td>
</tr>
<tr>
<td>Control</td>
</tr>
</tbody>
</table>
Similarly, to determine if the performance of control group started from the same level as the experimental group in addition, we conducted an independent sample t-test between the pre-test of the two groups. The dependent variable was the student's pre-test score for addition. The t-test for equality of means was significant ($t = 5.563$, $p = 0.001$), indicating significant differences initially, in mathematical achievement for addition between the experimental and control groups. Though the experimental group had a mean score higher than the control group, the mean difference in the pre-test scores was $0.935$. The results of this test are summarized in Table 4 and Table 5.

### Table 4. Group Statistics of pre test.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>86</td>
<td>18.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Control</td>
<td>93</td>
<td>17.064</td>
<td>1.559</td>
<td>.161</td>
</tr>
</tbody>
</table>

### Table 5. Independent Samples Test of pre test.

<table>
<thead>
<tr>
<th>t-test</th>
<th>df</th>
<th>Mean difference</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.563</td>
<td>177</td>
<td>.935</td>
<td>.001</td>
</tr>
</tbody>
</table>

In order to determine if the performance of the experimental group is significant than the control group after the teaching intervention the analysis of ANCOVA on the students' post-test scores of addition was carried on. After adjusting the scores for mathematical achievements of addition in the pre-test (covariate), the following results were obtained from the analysis of covariance (ANCOVA). A statistically significant main effect was found for type of intervention on the post-test scores for mathematical achievements, $F(1, 176) = 13.147$, $p = .001$, $\eta^2 = .070$; thus, after the teaching intervention the experimental group performed significantly higher in the post-test than the control group, as summarized in Table 6.

### Table 6. Comparison of student scores in post-test: ANCOVA analysis.

<table>
<thead>
<tr>
<th>Sources</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Squares</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>.161</td>
<td>1</td>
<td>.161</td>
<td>.020</td>
<td>.887</td>
<td>.000</td>
</tr>
<tr>
<td>Group</td>
<td>103.941</td>
<td>1</td>
<td>103.941</td>
<td>13.147</td>
<td>.000</td>
<td>.070</td>
</tr>
<tr>
<td>Error</td>
<td>1391.494</td>
<td>176</td>
<td>7.906</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results of this study expand the research on the effects of appropriate software embedded in a computerized environment as a tool for mathematical reasoning used alongside with specially designed activities [3], [10], [13]. Also, the outcomes of the present study create a new teaching model...
with computer and non-computer activities based on the theoretical framework that blends together Realistic Mathematics Education and tablet computers in the first grade level [21].

4 CONCLUSIONS

The purpose of the study was to investigate the impact of the intervention of FGTAM in regards to the mathematical competence of the first grade students.

In this research, we found that the students who were taught with educational intervention based on the ‘First Grade Tablet Addition Model’ FGTAM had a significant improvement on their general mathematical achievement in comparison to those taught using the traditional teaching method according to the first grade curriculum. Our findings agree with similar researches [3], [10], [13], [21] which implied that ICT helps students to understand mathematical notions more effectively. As a result, the first research question answered positively.

Moreover, we found that the students that taught with the educational intervention based on FGTAM had a significant improvement on addition in comparison to those taught using the traditional teaching method according to the first grade curriculum. Our results overlap with the results of other analogous studies which indicate the positive effects of a computer based-model of teaching math [2], [23], [24]. Therefore, the second research question was confirmed.

The current findings add to a growing body of literature supporting the effective role of educational software in education and more specifically in mathematics [23], [24]. Furthermore, the undertaken tablet computer assisted educational procedure revealed an extended interest for the tasks involved from the part of the students which transformed the whole procedure into a thorough, focused, independent learning environment.

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REFERENCES


