THE USE OF ICT IN TEACHING SUBTRACTION TO THE FIRST GRADE STUDENTS

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Abstract- The aim of this study is to investigate the question: "Can Information and Communications Technology (ICT) helps to improve primary school students' mathematical achievements for subtraction?" The applied educational software consisted of a story and several activities with and without the use of computers which were designed following the background of Realistic Mathematics Education for mathematical concepts; referred to as the 'First Grade Subtraction Model' (FGSM). In addition, we use the mathematical test TEMA-3 to explore the use of ICT 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 study dealt with students in the first grade of primary school of Athens, who were divided into two teams (experimental and control). The experimental group consisted of 35 students, who were taught of subtraction by the support of computers. There were 42 students in the control group, which received only the traditional science instruction for subtraction. Students in both groups were pre-tested and post tested for their mathematical performance. The results of the study indicated that teaching and learning through ICT is an interactive process for children at primary school level and has a positive effect for mathematical education of subtraction.

Keywords- ICT, Realistic Mathematics Education, Subtraction, First Grade.

I. 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]. Thus it becomes obvious that primary school emerges as a very attractive environment of investigating the computer use in education of mathematics.

II. RATIONALE

A vast number of studies show a positive interrelation between the use of computers and the development of mathematical thinking in school [11], [12]. Nonetheless, computer based activities should reflect the theoretical ideas behind them [13], [14], [2].

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). Realistic Mathematics Education (RME) is a theory of teaching and learning mathematics which started as a movement in the late 60s in the Netherlands in an effort of reconsidering mathematics education, where the mechanistic approach was dominant until then. Starting in 1968 with Wiskobas [15], a program initiated by the Dutch government, a new approach on mathematics education made its first steps offering an alternative to the American "New Mathematics," threatening at the time to invade the Dutch mathematics education [16]. RME is an active and constantly evolving theory of teaching and learning mathematics [17]. 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 [18], [19].

In the whole trajectory of the RME teaching theory, five main characteristics of understanding mathematical concepts are involved:

1) introducing a problem using a realistic context;
2) identifying the main objects of the problem;
3) using appropriate social interaction and teacher intervention to refine the models of the problem;
4) encouraging the process of reinvention with the development of the problem; and
5) focusing on the connections and aspects of mathematics in general [17].

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 Subtraction Model

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(FGSM) which consisted of five levels.
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 FGSM 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 subtraction with educational intervention based on FGSM will have a significant improvement on subtraction in comparison to those taught using the traditional teaching method.

III. 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.

A. Subjects

The study was carried out during the 2012-13 school year in four public primary schools located in the city of Athens. It was an experimental research which compared the ICT teaching process to traditional teaching based on the first grade curriculum. The sample included 77 first graders consisting of 39 girls and 41 boys aged six to seven years old. There were two groups in the study, one control (n=42) and one experimental (n=35). In the control group there was not a computer available for the students to use. The classes in the experimental group had a computer 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.

B. Educational Measures

In the first phase, the pre-test was given to the classes of the experimental and control groups during the beginning of September 2012 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 the Test of Early Mathematics Ability third edition (TEMA-3) [20].
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 [21].

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, subtraction (Fig. 1), multiplication.

Each task had a grade that was computed from the student's answers. Scores were computed for each of the individual mathematical tasks of the TEMA-3. Since the weight of problems varied across tasks, the total correct responses for each of the seventy two tasks were produced by adding the all correct responses of each problem on that task. The THEMA-3 is not a timed test; therefore, no precise time limits are imposed on the children being tested. On average, students will be able to complete the relevant portion of the test in 45 to 60 minutes.

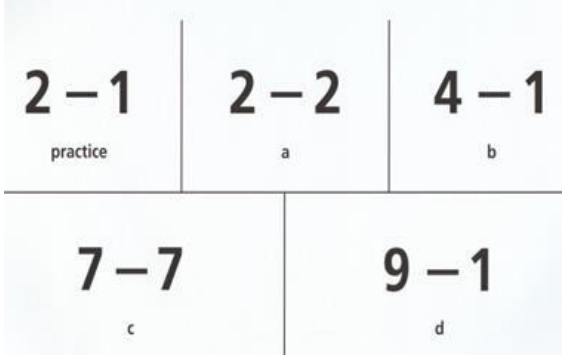

Fig. 1. Child has to do the subtraction

C. 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 FGSM procedure. The content of the four week syllabus of the FGSM was divided into five levels. The first level of the teaching intervention a story called 'An adventure in the forest' was presented to the students using a computer (Fig. 2). It was designed using Flash CS3 Professional Edition and presented with a video projector in the classroom. In this story Little Red Riding Hood and the Seven Dwarfs were friends and played games. Later in the story, the Big Bad Wolf kidnapped some of the Seven Dwarfs because he was hungry. In the end they became friends and everybody was happy. Then a child repeated the story and the students painted some

of their favorite characters of the story (Fig. 3). The second level started with an activity which the students identified the main objects of the subtraction by counting objects. The teacher gave three candies to John. Then George took two candies from George. Then, she asked the children, "How many candies has John now?" Another activity was a dice game and the student had to subtract the numbers by counting (Fig. 4). Finally, a computer activity took place with problems of subtraction (Fig. 5).



Fig. 2. The story 'An adventure in the forest' was the teaching intervention of the first level



Fig. 3. The students painted some of their favorite characters of the story (first level)



Fig. 4. The student in the dice game activity had to subtract the numbers (second level)

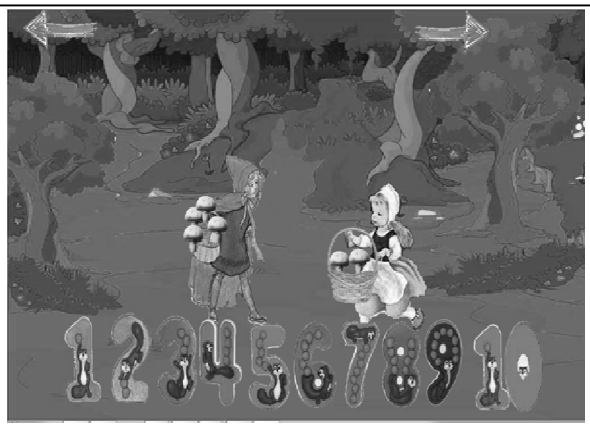

Fig. 5. Computer activity took place with problems of subtraction (second level)

The third level of the teaching procedure the children played the "Supermarket" game. One student played the customer who wanted to buy something and the other student acted as the employee. For instance, the teacher said, "John had four euro and wanted to buy one thing." Next, the students had to construct the problem of the using mathematical symbols e.g. numbers, the minus sign and the equal sign (Fig. 6). The final part of this level involved a computer-based group activity in which the student had to construct the mathematical problem (Fig. 7).

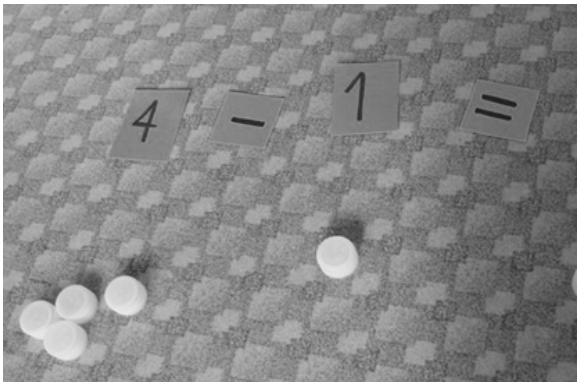

Fig. 6. The student had to construct the mathematical problem with number for subtraction (third level)



Fig. 7. The student had to construct the mathematical problem (third level)

In the fourth level of the teaching procedure, according to the RME theory, 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 (Fig. 8). Next, the children played a card game where each card had a subtraction problem which was showed to the students only for 10 seconds (Fig. 9). Finally, a software activity followed with hidden objects.

In the last level of the teaching process, the activities focused on the connections and aspects of mathematics in general. The students are separated into groups and played the game "Supermarket" (Fig. 10). One student was the buyer and the other was the employee of the super market. 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 thing cost. Afterwards, there were computer activities where the children had to find the missing number of a subtraction problem (Fig. 11).



Fig. 8. The game with cards (fourth level)

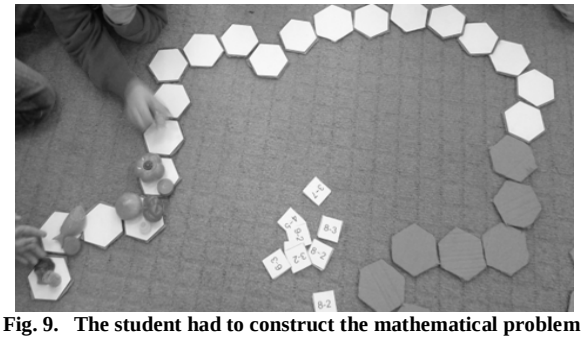

Fig. 9. The student had to construct the mathematical problem (fourth level)



Fig. 10. Students in the fifth level were playing the game "Supermarket" (fifth level)

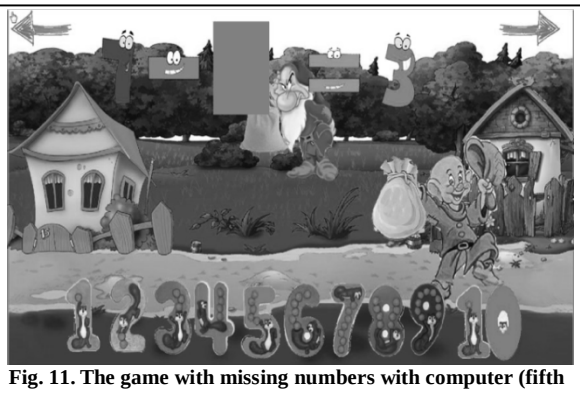

Fig. 11. The game with missing numbers with computer (fifth level)

Similarly, during the third and final phase of the study, after the teaching intervention, the same test (TEMA-3) was given to all students in both the experimental and control groups as a post-test at the end of October 2012 to measure their improvement on general mathematical ability and subtraction.

IV. 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 (experimental group) and no exposure (control group).

The dependent variable was the student's pre-test score. Levene's Test for equality of variances was not significant ($F=1.162$, $p = 0.284$). The t-test for equality of means was significant ($t = 2.624$, $p = 0.011$), 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 14.643. The results of this test are summarized in Table I and Table II. 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. Before conducting the analysis of ANCOVA on the students' post-test scores for total mathematical achievements to evaluate the effectiveness of the intervention, a check was performed to confirm that there were no violations of the assumptions of homogeneity of variances [22]. The result of Levene's test when pre-test was included in the model as a covariate was not significant, indicating that the group variances were equal, $F(1, 75) = 2.063$, $p = .155$; hence the assumption of homogeneity of variance was not been violated. 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, $F(1, 74) = 11.676$, $p = .001$, $\eta 2 = .136$; thus, after the teaching intervention the experimental group performed significantly higher in the post-test than the control group, as summarized in Table III and Table IV.

TABLE I. GROUP STATISTICS OF PRE TEST

Group	N	Mean	Std. Dev.	Std. Error
Experimental	35	57.14	22.768	3.848
Control	42	42.50	25.644	3.957

TABLE II. INDEPENDENT SAMPLES TEST OF PRE TEST

Pre-test	t	df	Mean difference	Sig. (2-tailed)
t-test	2.624	75	14.643	0.011

TABLE III. LEVENE'S TEST OF EQUALITY OF ERROR VARIANCES

F	df1	df2	Sig.
2.063	1	75	.155

TABLE IV. COMPARISON OF STUDENT SCORES IN POST-TEST: ANCOVA ANALYSIS

Sources	Type III Sum of Squares	df	Mean Squares	F	Sig.	Partial Eta Squared
Pre-test	44312.779	1	44312.77	446.02	.000	.858
Group	1160.032	1	1160.032	11.676	.001	.136
Error	7351.906	74	99.350			

Similarly, to determine if the performance of control group starred from the same level as the experimental group in subtraction, 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 subtraction. Levene's Test for equality of variances was significant ($F = 5.661$, $p = 0.02$). The t-test for equality of means was not significant ($t = 0.485$, $p = 0.629$), indicating no significant differences initially, in mathematical achievement for subtraction 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 0.243. The results of this test are summarized in Table V and Table VI.

TABLE V. GROUP STATISTICS OF PRE TEST

Group	N	Mean	Std. Dev.	Std. Error
Experimental	35	2.31	1.922	.325
Control	42	2.07	2.473	.382

TABLE VI. INDEPENDENT SAMPLES TEST OF PRE TEST

Pre-test	t	df	Mean difference	Sig. (2-tailed)
t-test	.485	74.667	.243	.501

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 subtraction was carried on. After adjusting the scores for mathematical achievements of subtraction 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, $F(1, 74) = 11.216$, $p = .001$, $\eta 2 = .132$; thus, after the teaching intervention the experimental group performed significantly higher in the post-test than the control group, as summarized in Table VII.

TABLE VII. COMPARISON OF STUDENT SCORES IN POST-TEST: ANCOVA ANALYSIS

Sources	Type III Sum of Squares	df	Mean Squares	F	Sig.	Partial Eta Squared
Pre-test	517.187	1	517.187	113.43	.000	.605
Group	51.138	1	51.138	11.216	.001	.132
Error	337.404	74	4.560			

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 in the first grade level.

V. DISCUSSION

The purpose of the study was to investigate the impact of the intervention of FGSM 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 Subtraction Model' FGSM 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], [11]-[13] 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 FGSM had a significant improvement on subtraction 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 [14], [10], [2]. Therefore, the second research question was confirmed. During the study observational notes were taken by the teacher who reported that students in experimental group were eager to take their turn at computer and all of the children were generally attentive. The students in the computer group were able to use the computer with relative ease and exhibited mutual consulting, cooperation, and collaboration. The observations suggest that these students are more comfortable with the computer than children with less mathematical understanding. These results tend to support the conclusion that computers may not be equally beneficial to all students. For the students with less representational competence concrete instructional activities may be more appropriate. The current findings add to a growing body of literature supporting the effective role of educational software in education and more specifically in mathematics [18], [19]. Furthermore, the undertaken 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, quiet, independent learning environment reinforcing previous research conclusions [17].

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