Exploring students' attitudes to learning mathematics with the use of micro experiments via Information and Communication Technologies

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Abstract :

220 students of lower secondary education participated in a research aiming to explore their attitudes related to the utilization of microexperiments via information and communication technologies (ICT) in the classroom. Using a modified scale based on the scale of Pierce et al. (2007) data collected relevant to the students' confidence in mathematics, confidence with technology, attitude to learning mathematics with technology, and the way of students' engagement when using microexperiments and ICT. Data analysis shows that the 56% of the students believes that they benefit from the use of microexperiments in the context of the school classroom. Those students expressed that microexperiments helped them in understanding and learning mathematics as well as in exploration of mathematical ideas. It is shown, finally, that the utilization of the microexperiments contributes in developing a group-collaborating climate in the classroom.

Keywords-component; *education, mathematics, microexperiments, group collaboration*

I. INTRODUCTION

In the framework of teaching mathematics, the utilization of manipulatives, representational means and digital technologies (DT), contributes in students' experimenting, conjecture developing, mathematical ideas' discovering and finally in conjecture documentation, by means of mathematical argument. This study focuses on the case of engagement and utilization of teaching mathematics with DT. Recently, the Greek ministry of education launched "Digital School" to be the main component of the vision for the "New School". In this effort, the school books turned from printed form into a digital one and they were also enriched with digital applications (microexperiments), aiming to become the catalyst for the change of:

- the content of the curriculum and school knowledge
- the teaching and learning process
- the relationship between students and teachers
- the relationship between parents and school [1].

Particularly, the enriched mathematical school books of lower secondary education include hundreds of microexperiments, which can be used as they are or they can be reconstructed by the teachers according to their personal point view or their students' needs. Microexperiments have been developed through the educational software: GeoGebra, Function Probe, Geometer's Sketchpad and Turtleworld. These constructions have been incorporated in different parts of the syllabus and they may be connected with activities, examples, exercises, as well as with definitions and mathematical properties.

Although the main purpose of the microexperiments is to be easy handled by the students, with cooperative orientation (mainly) under the guidance and support of the teacher, the existing school context and the lack of appropriate laboratory environment for the teaching of mathematics, usually leads to the utilization (in the traditional school classroom) by means of an interactive blackboard or a computer and a video projector, in order to explain notions and to investigate mathematical ideas for the whole of the classroom [2].

The enrichment of the school books was a “teaching armamentarium” for the teachers who would like to utilize the DT, but they didn’t know how to construct microexperiments. On the other hand, this enrichment supported the work of the teachers who knew how to construct microexperiments, by giving them the opportunity to add/incorporate them in their own digital library.

In the present work firstly we will (briefly) describe the utilization context of the microexperiments in the school unit and we will continue by presenting the results of a research which took place in our school, with the participation of 220 students, related to the use of microexperiments in the school classroom.

II. THE FRAMEWORK FOR INCORPORATION AND UTILIZATION OF THE MICROEXPERIMENTS

In the school unit, educational software programs such as Euclidraw, GeoGebra and the Geometer's Sketchpad, have been used for many years. However, the widespread of Geogebra, the development and the availability of a number of its applications, from domestic teachers and also from the international community, has lead the teachers of the school in the further use of the specific software and develop a large number of applications [3]. All the available microexperiments from the digital school (since the academic year 2011-2012), were studied and they were included in the framework of mathematics teaching, along with the applications that teachers of mathematics of the school had already developed. The selected microexperiments were uploaded at Blackboard platform which is the school lesson management system (LMS), with the citation of the source reference. In this way, microexperiments are now part of the daily teaching process and they are used every time the teacher or a group of teachers believes that it will be helpful for the students.

III. RESEARCH METHOD

In order to study the aspects and the attitudes of the students for the utilization of the microexperiments in the mathematics classroom, a modified scale was used, based on the Mathematics and Technology attitudes scale (MTAS) of Pierce et al. [4]. According to its developers, the initial scale can be used for the investigation of students’ attitudes and the level of their engagement in the classroom, in relation to DT. The constructors’ scale consists of 20 items. These items are divided into subscales: mathematics confidence [MC], confidence with technology [TC], attitude to learning mathematics with technology [MT], affective and behavioral engagement [ABE] with mathematics. Students are asked to indicate the extent of their agreement with each statement, on a five-point scale (Likert-type scoring format) from strongly agree to strongly disagree (scored from 5 to 1). According to its developers, students will need 15 minutes for the completion of the scale. For details see [4].

The scale was modified so that microexperiments will be inserted into questions, while the phrases referring to scientific/graphic calculators were eliminated from the items, as they are not used by the Greek school mathematical community. For example, the statement: “Mathematics is more interesting when using graphics calculators.” was turned into: “Mathematics is more interesting when microexperiments are used”. Furthermore, there are two items in order to investigate issues of group-collaboration. Through the use of that scale data were collected related to:

- mathematics and technology confidence,

- students attitude in learning mathematics wit DT,
- the students engagement when DT are utilized.

The modified scale was examined for its reliability according to Alpha coefficient (Cronbach Alpha), evaluating the internal consistency of its propositions. According to Fornell and Larcker, Cronbach's alpha value greater than 0.7 indicates a high reliability [5]. The result of the test revealed acceptable indices of internal consistency is 0.771.

In the present research, 220 students (male and female) from three classes were participated. The female students were 115. The research took place in the beginning of the second semester, when students had already worked with microexperiments in the classroom and had already taken the grades of the first semester. In this paper we present the results of the descriptive statistics, as well as some conclusions from the analysis of the differences between samples, using X^2.

IV. RESULTS

A. Students' aspects related to mathematics

On a percentage of 70% students consider to have confidence with mathematics (Figure 1), while 78.5% consider achieving good results in mathematics.

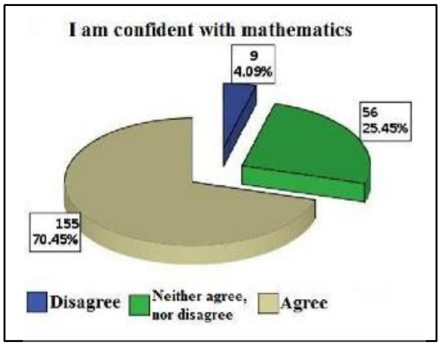

Figure 1. Students' answers "I am confident with mathematics"

52.5% of the students consider having a mathematical mind, while 44% (approximately) consider handling difficult mathematical issues. Although 7 out of 10 students declare that they are interested in learning new things in mathematics, only half of them believe that learning mathematics is enjoyable (Figure 2).

Moreover, 76% of the students feel satisfied when they solve mathematical problems. On the other hand, 4 out of 10 students mention that if they have done a mistake in mathematics, they will not try to locate and correct it. On a similar percentage, students will not continue trying to investigate a mathematical issue, with new ideas or a new approach, if they "get stuck".

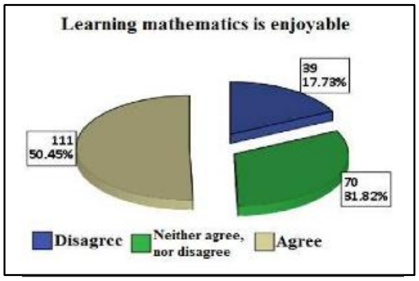

Figure 2. Students' answers "Learning mathematics is enjoyable"

B. Students' aspects related to technology

Students mention to be familiar with DT and also good users of DT. A small percentage of 5% mentions to be inadequate in the use of computers, while the percentage becomes even smaller (2.5%) when it comes to the use of other technological tools, such as mobile phone, mp3 etc. However, when they were asked if they can handle any computer program in school, a percentage of 60% replied positively, while 1 out of 4 gave no answer.

C. Students' aspects related to microexperiments

Students, on a percentage of 64% mention that mathematics is more interesting when using computer and explore microexperiments. The percentage of positive answers increases up to 70% when they are asked if they like using computers and microexperiments to do mathematics (Figure 3).

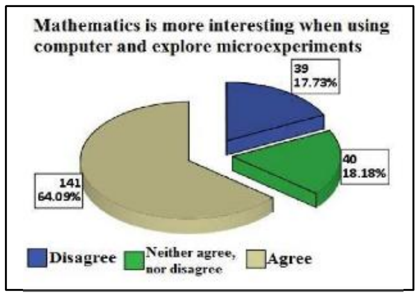

Figure 3. Students' answers "Mathematics is more interesting when using computer and explore microexperiments"

On the other hand, 56% mentions that the microexperiments have helped them in learning better the mathematics that are taught, while in the matter of convenience to the way of investigation mathematical ideas, 55% of the students replied positively, although 1 out of 3 gave no answer (positive or negative). Finally, 52% of the students agreed that the microexperiments increased their willingness to cooperate with their classmates (Figure 4).

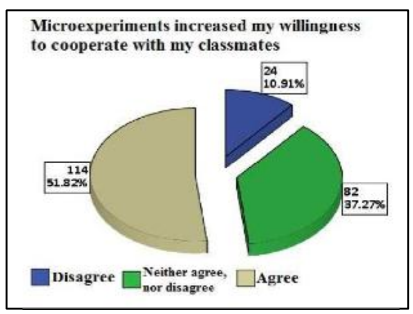

Figure 4. Students' answers "Microexperiments increased my willingness to cooperate with my classmates"

V. CORRELATIONS

A correlation analysis through the chi-squared (X^2) method followed, in order to locate statistically significant differences between the students' statements. Throughout this analysis the correlation of the use of microexperiments, with the confidence in mathematics and with the confidence in DT was investigated. For that purpose, the answers: "I totally agree" and "I agree" grouped as one variable, and "I totally disagree" and "I disagree" as another variable. From the analysis the following results appeared:

A. Correlation between confidence in the use of computer and in the use of microexperiments

There was a significant correlation between the answers in the statement "I am good at using computers" and in the statement "Mathematics is more interesting when microexperiments are used" ($X^2 = 19.87$, $DF = 4$, $p = 0.001$). It is possible for those who stated that they are good in the use of computers, to believe that mathematics is more interesting when microexperiments are used. At the same direction, there is correlation between the students' statements "I am good at using computers" and "I like doing mathematics through microexperiments" ($X^2 = 22.27$, $DF = 4$, $p < 0.001$).

B. Correlation between confidence in mathematics and students' cooperation when microexperiments are used.

There was a significant correlation between the answers in the statement "I am confident with mathematics" and in the statement "Microexperiments increased my mood for cooperation with my classmates" ($X^2 = 11.73$, $DF = 4$, $p = 0.019$). It is possible for those who stated that they are good in mathematics, to believe that microexperiments increased their mood for cooperation with their classmates. Similarly, there was a significant difference between the students' statements "Mathematics is more interesting when microexperiments are used" and "Microexperiments increased my mood for cooperation with my classmates" ($X^2 = 17.55$, $DF = 4$, $p = 0.002$). It is possible for those who stated that mathematics is more interesting through microexperiments, to believe that their mood for cooperation with their classmates, increased. As far as it concerns cooperation, it resulted that there was significant correlation between the answers in the statement "Microexperiments make easier the investigation of mathematical ideas" and in the statement "Microexperiments increased my mood for cooperation with my classmates" ($X^2 = 40.53$, $DF = 4$, $p < 0.001$). It is possible for those who stated that microexperiments make easier the investigation of mathematical ideas, to believe that microexperiments increased their mood for cooperation with their classmates.

VI. CONCLUSION

According to the data analysis, 64% of the students seem to have a positive attitude in utilization of microexperiments, while 56% believe that microexperiments have helped them in the classroom. Moreover, it seems that students who have mentioned that are confidence with mathematics, have a positive attitude in teaching mathematics with the use of DT. This is an outcome that agrees with the research of Barkatsas et al. [6]. However, students with a negative attitude toward mathematics and low level mathematical confidence seemed not to be affected by the use of microexperiments and they did not seem to modify their attitude. Moreover, the outcomes agree with the research of Vale and Leder, in which it is stated that students who are good users of computers, want to learn mathematics with the use of computers [7]. On the other hand, it seems that the utilization of microexperiments contributes to the development of a group-collaboration climate, which is very important in the contemporary mathematical classroom [8]. Moreover, students who agree with the use of microexperiments, mention that microexperiments have helped them in better learning of the mathematics taught.

VII. EPILOGUE

Microexperiments are now an additional component of the mathematical classroom in Greece. In the context of this new school they are considered as one of the pillars of students' mathematical education. This attempt is very important because teachers acquire a critical and a creative role, through these –open to modify– structures [9]. The material obtained by the digital school, can be modified by teachers and it can be shared to other teachers as well. At the same time, they have the opportunity to focus on each student, on a group of students, on the classroom practices or at the world outside the classroom. Furthermore, all of these structures are matched with activities, examples and exercises from the school books. Simultaneously, they have been developed according to the curriculum, highlighting the relationship between the curriculum and the DT.

It arises the importance for the teachers to be prepared to utilize DT in teaching mathematics since, on one hand, the research in the field of mathematical education emerges the benefits of this use and, on the other hand, the daily involvement of the students with the DT, contributes in the development of a utilization framework and incorporation of DT in the teaching process [10]. The development of an "enriched" curriculum, which will describe the utilization of microexperiments, may probably support the needs of the teachers, but also contributes to the optimization of the teaching and learning process, for students' benefit.

Finally, the coexistence of the traditional school book along with the enriched (digital) book is a challenge for the teacher. Teachers must not just decide if they will utilize the given digital material, but they will also have to decide critically the way of this utilization. He will have to act by emancipated orientation and take advantage of the technological, pedagogical content knowledge which possesses.

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