

Effectiveness of Using GeoGebra in Mathematics

Sindize Jusufi¹ and Stojan Kitanov²

Abstract – The rapid growth of Information and Communication Technology results with the software used in education. This paper explores the effectiveness of GeoGebra software in learning the 7th grade elementary school mathematics among 50 students. The results show that students have a positive perception of learning mathematics and have better learning outcomes using GeoGebra.

Keywords – GeoGebra, digital educational content, educational software, educational technology, learning performance, mathematics.

I. INTRODUCTION

The rapid growth of Information and Communication Technology (ICT) resulted with a powerful learning resources in the education. One such tool that can help teachers to design effective learning lessons in mathematics is GeoGebra [1]. GeoGebra is a dynamic software for teaching and learning mathematics. It is a computer program (software) for mathematics, especially for the learning of geometry and algebra [2], [3]. Although GeoGebra has not yet been widely used in teaching mathematics in Macedonia, it improves the learning efficiency, because it allows easy access to information which facilitates the learning.

This paper explores the different methods and activities that would positively influence the student to solve the problems and mathematical tasks, by using the GeoGebra software. It also aims to prove the extent to which technology tools can influence their teaching and learning in the subject of mathematics.

The rest of the paper is organized as follows. Section II states the problem motivation and related work. Section III provides information on the research methodology. Section IV performs analysis of the results. Firstly, it makes a comparison of the learning performances of the students who studied mathematics classically and the learning performances of the students who studied mathematics with GeoGebra. The results show better learning performances of the students that used GeoGebra. At the end, an analysis of the results from the question survey about the effectiveness of using GeoGebra in learning and understanding the mathematical topics was performed. The analysis of the results confirm the fact that the use of GeoGebra in teaching positively influences students' understanding and knowledge. Finally, Section V concludes the paper, it gives some recommendations, as well as some future work directions.

¹Sindize Jusufi is with the Faculty of Informatics at Mother Teresa University, Skopje, Macedonia, E-mail: sindize.jusufi@students.unt.edu.mk.

²Stojan Kitanov is with the Faculty of Informatics at Mother Teresa University, Skopje, Macedonia, E-mail: stojan.kitanov@unt.edu.mk.

II. PROBLEM MOTIVATION AND RELATED WORK

Some of the factors that affect the students' attitude towards efficient learning of mathematics are the learning materials used by teachers, classroom management, teaching methods, teacher's knowledge and personality of the content, as well as similar and related topics with the real-life situation. The learning materials and methods that are used by the teachers are either conventional classic educational materials or methods, or can be digital educational software together with online learning management system such as Moodle, Google Classroom, etc. Although the teaching methods in Macedonia are still classical, our motivation was to improve the learning outcomes of the students in mathematics, by using the GeoGebra software, because nowadays technology plays an important role in the development of the educational process.

Several studies have been conducted about using GeoGebra in secondary and elementary schools in the world [3]. To our best knowledge no similar research has been performed so far in Macedonia. One approach, which is very close to our research methodology, is given in [4]. Here are shown the performances of students' achievements by using GeoGebra particularly in statistics. In this research study, firstly pre-achievement tests were analyzed. Then, the students learned statistics with GeoGebra and after that post-achievement tests were analyzed. At the end a survey questions were answered by the students about the effects of learning statistics with GeoGebra. However, this approach does not consider the classical learning and it does not measure the effectiveness by the classical learning methods. Our research methodology includes this.

III. RESEARCH METHODOLOGY

The research methodology is given in Fig. 1. It consists of 5 phases.

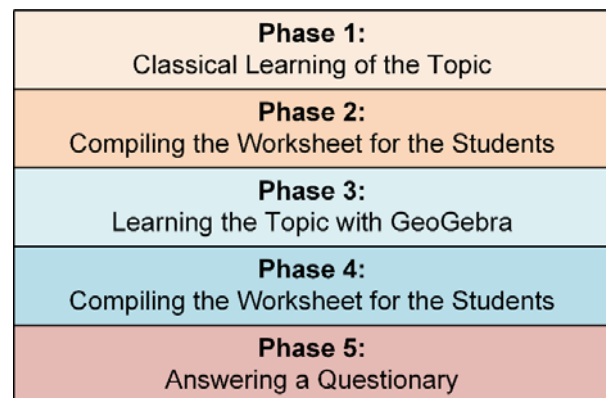


Fig. 1. Phases of the Research Methodology

In the **first phase** the mathematical teaching unit topic is classically explained. In the **second phase** a worksheet for the students is compiled, in order to understand how much the students have learned the mathematical unit topic with the classical teaching method. During the **third phase** the teaching unit is explained with the application program GeoGebra. In the **fourth phase**, a worksheet for the students is compiled again in order to understand how much they understood the methodology unit with GeoGebra. Finally, in the **fifth phase** a questionnaire survey was answered by the students in order to see the evaluate the impressions about the explaining teaching units with GeoGebra. The worksheets were used to compare what the students knew when the lesson was classically explained and what they knew after the lesson was explained with the GeoGebra program. The questionnaire contains statements that reflect students' perception of using GeoGebra software. Table I summarizes the questions included in the question survey, as well as its possible answers.

TABLE I
QUESTION SURVEY

Question	Possible Answers
I want to learn Mathematics	Always Sometimes Never
Mathematics is difficult	Always Sometimes Never
Students understand the tasks of mathematics	Always Sometimes Never
Mathematical tasks are done by the students themselves	Always Sometimes Never
How do the student understand mathematics with GeoGebra	Nothing Slightly Somewhat More Much More
Student easily understand the mathematical tasks and Problems with GeoGebra	Always Sometimes Never
Do you want to continue to study mathematics with GeoGebra	Yes No

The research methodology was conducted in the primary school "Adem Jashari" in Skopje from 17 April to 30 April 2019, in a 7th grade class of 50 students. The topic that was taught was 3D formats. The research was done after the explanation of the "3-D format" teaching. Some techniques are used for data collection such as worksheets and questionnaires for students.

IV. ANALYSIS OF THE RESULTS

The results of the research methodology, are shown in the following two subsections. Subsection A analyzes

performances of the students for the planned work, i.e. the results of the students when the topic is classically delivered to the students and the results when the topic is explained to the students with GeoGebra. Subsection B analyzes the results of the question survey.

A. Results of the Students for the Planned Work

The results based on the first job sheet (Phase 2 of the research methodology), i.e. when the mathematical classes are explained to the students with the classical and conventional teaching methods are provided in Fig. 2. The students' test results show that 42% of students have given the correct answer, while 58% of the students have given incorrect answers.

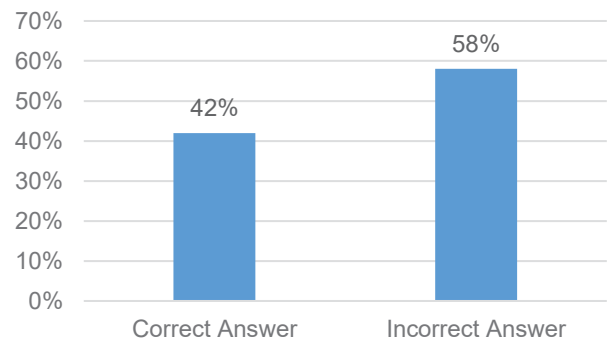


Fig. 2. Results of the Assessment when Mathematics is taught with Classical Methods

The results based on second working paper (Phase 4 of the research methodology), i.e. when the mathematical classes are explained to the students with the GeoGebra are provided in Fig. 3. It can be noticed that that 78% of the students have answered correctly, while the remaining 22% didn't provide correct answers.

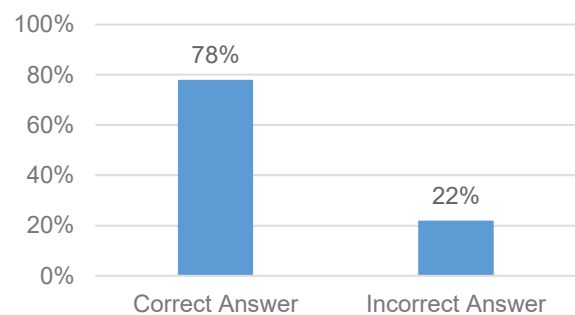


Fig. 3. Results of the Assessment when Mathematics is taught with GeoGebra

It can be concluded that when GeoGebra is not used in teaching mathematics students provide more incorrect answers. If GeoGebra is used for teaching mathematics students provide much more correct answers.

B. Results of the Question Survey with the Students

The results of the question survey with Students (Phase 5 of the research methodology) are provided from Figs 4 - 10.

The results of how much the students want mathematics are displayed in Fig. 4. It can be noticed that about one third of the students love to learn mathematics, almost two thirds students sometimes love to learn mathematics and very small number of students never want to learn mathematics.

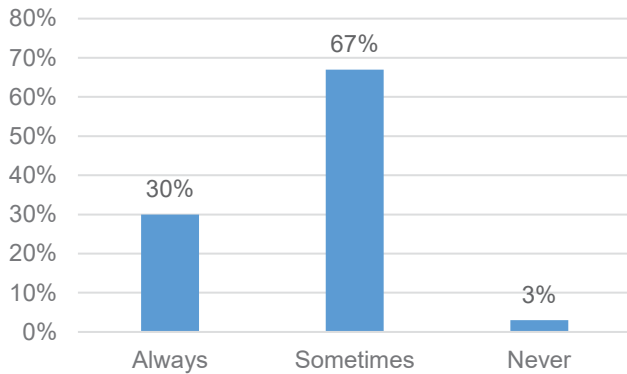


Fig. 4. Students Want to Learn Mathematics

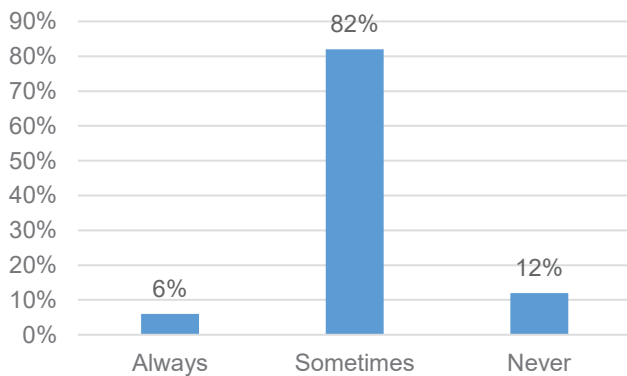


Fig. 5. Mathematics is Difficult for the Students

The results of how much mathematics is difficult for the students are displayed in Fig. 5. More than 80 % have stated that mathematics sometimes is difficult to learn, about 12 % have stated that mathematics is never difficult to learn, and about 6 % stated that mathematics is always difficult to learn.

The results of how much students understand the tasks from mathematics are provided in Fig. 6. About 80 % of the students have stated that always understand the tasks of mathematics, 16 % of the students have stated that sometimes understand the tasks of mathematics and very small number of students (about 4 %) do not understand the mathematical tasks.

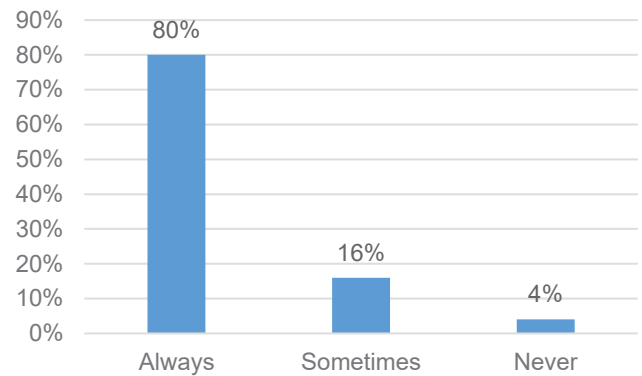


Fig. 6. Students Understand the Tasks of Mathematics

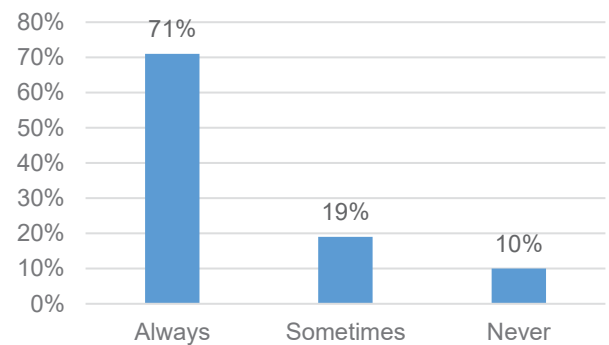


Fig. 7. Mathematical Tasks are Done by the Students Themselves – Without Any Help

The results of how much the mathematical tasks are done only by the students themselves are given in Fig. 7. More than 70 % of the students always do the mathematical tasks by themselves, almost 20 % of the students sometimes do the task of mathematics with the assistance from others, and 10 % of the students never do the mathematical tasks by themselves.

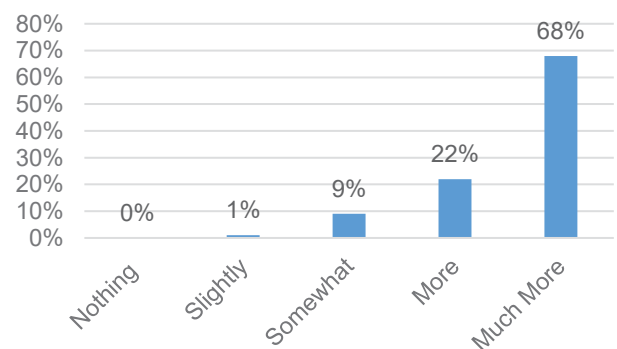


Fig. 8. How much the Student understands Mathematics with GeoGebra

The results of how much the students understand the course mathematics with GeoGebra are given in Fig. 8. Almost 70 % of the students have stated that much more understand mathematics with GeoGebra, more than 20 % of the students have declared that understand more mathematics with GeoGebra, almost 10 % of the students have stated that slightly somewhat understand mathematics with GeoGebra, and 1 % of the students have stated slightly understand mathematics with GeoGebra. In general, it can be concluded that most of the students understand better mathematics with GeoGebra.

The results of how each student easily understands the mathematical tasks with GeoGebra are provided in Fig. 9. All students have stated that always understand the mathematical tasks with GeoGebra, which corresponds to the same conclusion extracted from Fig. 8.

Finally, answers whether the students would like to continue to study mathematics with GeoGebra are provided in Fig. 10. All of them stated that they would like to continue to learn mathematics with GeoGebra software, because most of them have improved the learning efficiency in mathematics, even those who thought that mathematics is not easy to learn.

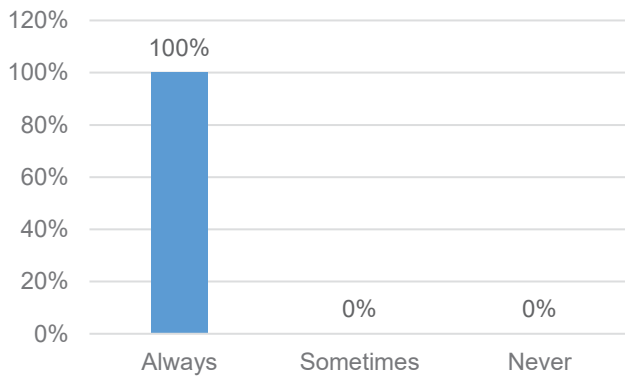


Fig. 9. Students Easily Understand the Mathematical Tasks and Problems with GeoGebra

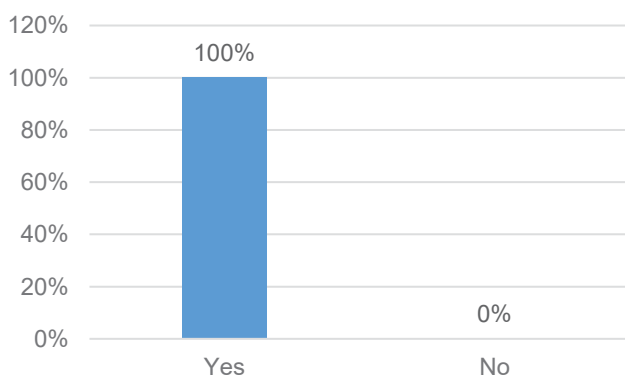


Fig. 10. Students Would Like to Continue to Study Mathematics with GeoGebra

V. CONCLUSION

This paper was about the effectiveness of using GeoGebra software in learning mathematics. Firstly, it was stated the motivation for this research and the related work. Then the research methodology was provided. Finally, the obtained results were analysed and discussed.

The results from this research proved that mathematics can be learned more effectively and more efficiently by the use of GeoGebra, or even any other software, because it makes the subject topics more interesting, and easy to learn like other subjects. Also, this research made it possible to change the persuasions of students who considered the subject of math very difficult to learn. Students can benefit from the GeoGebra software in learning mathematics, because they can interact with technology. They use the Internet, cell phones, computers, laptops, tablets and other software to communicate with others. The digital environment increases the students' motivation and self-confidence in learning mathematics. Therefore, GeoGebra should be introduced to math educators so that students can explore the world of mathematics in a broader way. Moreover, GeoGebra in the process of learning the mathematics would introduce new innovative teaching and learning methods for the students.

However, this research was performed with a small number of students and classes. The results would be even more compelling if more students were involved. Likewise, the duration of the research may also be a restrictive circumstance for the results to be even more convincing.

In the future our plan is to make a more deeper research with greater number of students in order to obtain more realistic results, as well as the obtained results would be analyzed with other statistical methods and software tools.

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