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Impact and Management Strategies of Using Educational Technologies by School Teachers while Teaching Algebra

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INTRODUCTION

Significance of research

In the changing environment of education, caused by the usage of technology in all spheres of life, students learning motivation is decreasing rapidly (Rufini et al., 2012). Prensky (2001) stated that the students of our century are changing and they are not like the students of previous century's educational system. Teachers and academics need to motivate students, using innovations in pedagogy and technology. For this reason we need to examine innovations in the education system and these innovations must include modern technologies. If a technological device can be used in education, it can be called a part of educational technologies. For example, using the smartphone in education makes it an educational technology equipment.

Today, many countries have realized this need and started to introduce some innovations in their education systems. Some examples of these innovations involve: The Microelectronics Education Programme (MEP, 1981) in the UK, Millennium Project in Japan (2007), and Fatih Project in Turkey (2010). According to British Education Suppliers' Association (BESA) 2015 report, the UK has taken numerous steps in this direction since 1981, in 1997, for example, the British government announced that it would place interactive whiteboards in classrooms throughout the United Kingdom. Every UK school nowadays has a learning platform giving pupils access to curriculum materials 24/7. In Japan the aim of the reform in education was to start internet and technology-based education and it was called as Millenium Project (Mizukoshi, 2007). In Turkey in 2010 the wide-scale application of tablet PCs, interactive whiteboards and internet in education started. With the advent of the Internet, information-on-demand has become a reality (Bleecker, 2008). The 2005 reform in education in Norway reform aimed at supporting economical development. They have greatly increased the abilities of students in technological innovations and science (Balanskat, Blamire & Kefala, 2006). The majority of the developed countries started to use modern technologies in their education systems, such as the United States, South Korea, Hong Kong and Singapore (Akpinar & Aydin, 2007). Some of these innovations may not be successful enough, but it is understood that the usage of technology in education is one of the most important issues of education systems in the future.

Recent studies on the use of technology in education have demonstrated a great number of benefits (Granito & Chernobilsky, 2012; Kennewell et al., 2007; Kulik&Kulik, 1991; Liu et al., 2007; Miller, Glover & Averis 2005; Moffatt, 2000; Nan, 1994; Sivin-Kachala, 1998). Irrespective this, the teachers' attitude towards the usage of technology has not been sufficiently explored. Teachers' use of existing technological devices in their classrooms is not sufficient

(Gray, Thomas & Lewis, 2010; VeraQuest Inc., 2013). It is a contradiction that teachers believe in benefits of the technology, but avoid using it. One important step forward is to investigate the factors, underlying this fear of technology, and to expose the barriers of using technology in education. For this reason the researcher[1] prepared questionnaires for teachers from different countries and for students to investigate the underlying factors. To understand the impact of technology on teacher's attitudes, the first step was to conduct analysis of the current practice. Following that, this research set out to explore a model of teaching algebra with the use of educational technology in order to examine its impact on the 10th-grade students. For this reason, the researcher developed a model of teaching algebra with the help of educational technologies and investigated its impact on 10th-grade students of Private Demirel College Tbilisi, Georgia).

Novelty of research

While there many studies about using educational technologies in education, especially for language teaching and some other subjects, there are fewer studies dealing with teaching algebra with educational technologies. There are also many researches that are related to only one type of educational technology, for example, about the use of only computers in education or about the usage of smartphone and social media for education, etc. (Vinsonhaler, Bass & Ronald, 1972; Simon, 1981; Baker, Gearhart & Herman, 1994; Szabo and Poohkay, 1996; Moffatt, 2000; Henderson & Yeow, 2012; Beutner & Pechuel, 2011). The presented study deals with the issue from many viewpoints, including selection of technology and software, activities for their application, classroom management at algebra lessons, student and teacher attitudes and barriers in using technologies for teaching/learning algebra at high school.

A model of teaching algebra based on technology applications was developed by the researcher and its efficiency was tested and proved experimentally (at least, for the given students). The model increases student motivation and participation and due to it yields improved learning results.

The **purpose** of this study is to find out:
1. The impact of educational technology on students and demonstrate the use of educational technology in teaching algebra for grade 10.
2. The increase of students' motivation and achievement; to help teachers to present effective lectures, and provide the retention of learned topics.

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[1] here and further on, "the researcher" stands for the dissertation author Ahmet Cakir

3. An effective model of teaching algebra, avoiding the barriers with the help of educational technology.
4. The criteria for selecting or preparing effective educational software, providing advice and recommendations to the school managers and teachers on how to use educational technologies effectively.
5. The comparative efficiency of the traditional and new, technology-based model of teaching algebra.

Practical value of the study

The dissertation offers many useful practical recommendations on selection of technical devices, software and ready-made e-materials/programs, their application, corresponding activities and classroom management. It aims at changing teachers' beliefs concerning the application of educational technologies for teaching algebra and arming them with effective tools.

Theoretical value of the study

This research will provide insights into:
- methods of strategic use of educational technologies in algebra lessons;
- forming a model of teaching algebra with the help of educational technologies;
- methods of overcoming the teacher's barriers, while using the educational technologies;
- the needs of teachers to use the technology more efficiently and effectively;
- the criteria for preparing or selecting effective software for teaching mathematics.

Many researchers claim that the use of technological devices and suitable software for these devices help teachers to increase the motivation and participation of students (Clarke, 2001; Granito & Chernobilsky, 2012; Raines & Clark, 2011; Watson, 2015). So, the researcher will investigate this claim in connection with teaching algebra and find out the impact of the use of educational technologies in algebra classrooms. The use of technology helps teachers to grow up qualified and effective lectures (Cashin, 2010; Levine, 2002; Wood & Ashfield, 2008). Also, the use of technology in education increases the retention of the learned topics (Granito & Chernobilsky, 2012). This means that the application of technology in education is very important for educators. How can educators use educational technologies and which model should be used for effective algebra lessons? Also, what are the barriers to the application of

these technological devices? Based on these questions and claims of other investigators, the researcher formed the hypotheses of this study.

The **hypotheses** of this study are:

H1: The strategic use of educational technologies in algebra lessons increases student's motivation and achievement.

H2: Educational technologies make algebra lessons more attractive and increase the students' attitudes towards them.

H3: Educational technologies increase the retention of the learned topics.

H4: The application of technology is not effective automatically, but only through corresponding classroom management and activities.

H5: Many different technological devices can be used in algebra lessons, simultaneously.

To test the hypothesis, mixed **research methods** were applied.

Quantitative paradigm

In this study a Non-Equivalent Experimental Research design (Willigan & Lynch, 1982) was used. It was based on applying the suggested model in the experimental group, while traditional methods of teaching were used in the control group. The assessment of the learning outcomes in both groups, otherwise identic, was carried out with:

- a pre-test (before the study)

- post-test (upon the completion of the study)

- retention test (five weeks after the study was completed)

- statistical analysis of obtained experiment data

Qualitative paradigm

Open-ended questions in students' and teachers' questionnaires.

Questions for the first questionnaire for students were taken from Aşkar's (1986) mathematics attitude test. Questions of the second questionnaire of students were prepared by the researcher to analyze the impact of the used model of teaching algebra. The questions of the first questionnaire for teachers were collected from different researchers' works and some of them were generated by the author to analyze the teachers' beliefs on the application of technology in education and, in particular, in algebra teaching. The other two teachers' questionnaires were

generated by the researcher to find the answers to the research questions and to support the research hypotheses.

Structure of the dissertation

The dissertation comprises the following parts: introduction, 3 chapters, conclusion and appendices. It involves 40 tables and 33 figures. Its volume is totally 157 pages (232 pages, including all parts and appendices).

CHAPTER 1: LITERATURE REVIEW

Developing the technology changed almost everything in modern life. Comparing todays' technologies with the technologies of the previous decade shows great differences. These differences have changed every sphere of life. Depending on the new inventions, people's needs have also changed. Once, computers were for only some elite people, but today it is a need for almost every person and every job (İnam, 1999).

The researcher used an inverted triangular explanation method for the development of his model. He started with general meaning of technology, then – of educational technology, and finally - of technology in teaching algebra. So, the researcher started with the meaning of the terms "technology" and "educational technology" and the history of technology applications in various spheres, including education. People used the term "technology" as the tools or activities that we use to seek changing or manipulating the environment (Buchanan, 1992).

Educational Technology can be defined as the application of technological tools effectively in learning. It is concerned with an array of tools including media, some types of electronic devices and networking hardware as well as considering the theoretical perspectives for their effective application (Richey, 2008). Throughout this dissertation when the researcher uses the term "educational technology" he means any device or software that can be used for educational purposes. Conceptions of the educational technology have been evolving as long as the field has, and they will continue to develop forever. Educational technology is defined as: "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (Januszewski & Molenda, 2008).

There are many advantages of using technological devices and software in education. Some of these advantages are: they help teachers to motivate the students, activate more students during the lesson, increase the achievements of the students, satisfy the demands of personal learning abilities, help students through the personal application of computers or software,

activate more senses (visual, auditory, tactile) of the students, help teachers in time management, help students and teachers to make a fast search of information, help students to revise the topics, to perform in class and at home, to eventually decrease the cost of education. The application of technologies helps in students' character formation (helps develop curiosity, resilience, etc.), it causes to integrate authentic materials into the classroom, increase the interaction between the students and teachers and among the students, it helps teachers to evaluate and assess students' knowledge and skills, to increase their creativity, make it easy to access course materials, prepare students for the future, change students' attitudes towards mathematics and improve the retention of the learned topics.

Besides these advantages, there are some factors that affect the use of technology. These are: the lack of the technological devices, time pressure for teachers to prepare the materials for technological devices, teachers' performance, socio–psychological development of students, students' and teachers' ability to use technology, technology and software cost, lack of resources, materials and software, ineffective application of technology, technical problems, problems related with evaluation and assessment, some students' and teachers' computer anxiety, laziness in studying, quality of curriculums, and even political problems, as well as rapid changes in technology and some organizational factors.

Many researchers (Baker, Gearhart & Herman, 1994; Henderson & Yeow, 2012; Hinterkthuer, 1985; Kulik & Kulik, 1991; Lee, 1990; Moffatt, 2000; Sivin–Kachala, 1998; Wood & Ashfield, 2008) worked on the use of different technological devices and software in education. But the majority of these researches are related to the usage of computers in education in general or the impact of one type of technological device or software on teaching a selected subject or topic.

In chapter 1 some widely-spread technological devices and equipment are viewed. These are: audial devices, TV and videos, overhead projectors, computers, projectors, smart boards, IPads, tablet PCs, and smartphones. A brief history of these devices is presented, the advantages and some disadvantages of each device is analyzed.

It is a fact that contemporary school children engage in online activities inside and outside of the classroom (Sefton–Green, 2004). So, researchers need to study the possibilities of the application of the Internet and its features. Wallace (2004) discusses that the Internet may be useful or harmful, depending on its implementation. In the first chapter the applications of the Internet, social media and Edmodo are described.

In the first chapter it is shown how the goals of teaching algebra are related to the application of educational technologies and how technologies turn this dry, abstract subject into a more concrete, understandable and enjoyable one.

Technology is an essential component in student–centered education, as it permits to realize individualized teaching inside and outside the classroom. According to Özer (2007), student–centered education is focused on the responsibilities and activities of the learners. On the other hand, traditional education is based on one authority that is the teacher and all activities are planned and executed by that authority (Hirumi, 2002). Technology–based teaching, compared to traditional one, permits to better consider both students' learning styles and instructors' teaching styles, the peculiarities of the educational materials and topics, type of work, etc.

The communication is an important issue of the 21st century. Because of this, scientists invented different communication methods. Technology provides unprecedented effective communication between school administration, teachers, students and parents, thus making the educational process more effective.

The chapter also describes some strategies for teacher training in use of technology. Some of these strategies are: purchasing the most effective technological devices, training the teachers to use these devices, monitoring the application of technological devices by the teacher and students during the lesson. Technology application should be equitably distributed among subjects, and they should be available to all students. Inexperienced / unskilled in technology application teachers need technical and pedagogical support in order to learn to use the technology efficiently. Teachers and students effectively using technologies should be motivated by a whole system of awards. However, it should be kept in mind that the main aim of using the technology in education is not just teaching the use technological devices, but teaching to use the technology in order to increase the quality of the lessons (Gimbert & Cristol, 2004).

CHAPTER 2: MODEL OF TEACHING ALGEBRA IN HIGH SCHOOL WITH EDUCATIONAL TECHNOLOGIES

In this chapter the model of management strategies of using educational technologies by school teachers while teaching algebra is developed step by step and then summarized. This model was applied in organizing the teaching of algebra in Private Demirel College 10th grades with the help of educational technologies. This chapter describes the potential of the devices and the software, the criteria of their selection, the process of selection of activities relevant for the particular device / software, and classroom management. The application of technologies for knowledge and skills' assessment, for providing student and teacher feedback is also emphasized.

The use of technological devices supports students in exploring and identifying abstract mathematical concepts. The following devices are involved in the suggested model: computer, projector, smart board, IPad, and smartphone. They were used in different parts of education process: teaching, learning, performing the activities, using the multimedia, playing games, assessment, communication, documentation and practicing. These devices are interrelated with each other.

Internet was also an indispensable part of the model. The use of the Internet and social media in education increase students' access to information, ideas, and interactions. This access to information supports and enhances the process of taking ownership of knowledge. Students share knowledge and learning / problem-solving strategies, while they communicate via the Internet with their group-mates and other peers or with the teacher. The possibilities of asynchronous communication via e-mail, blogs, interest/chat groups, etc. enable everybody to choose the convenient timing for studies and study-related communication.

Strategic use of technological tools can support both the learning of mathematical procedures and skills and the development of advanced mathematical proficiency, including problem solving, reasoning, and justifying (Gadanidis & Geiger, 2010; Pierce & Stacey, 2010).

Discussing software, the researcher divides it into two groups: general purpose software and special software. General purpose software is the software that many people and branches use for different reasons. For example; Microsoft PowerPoint, Word, Excel, and ActivInspire. Special software is used especially for mathematics. These are, Geometer's Sketch Pad, MathType, Derive, Geogebra, Android and iPad applications, also Zambak Interactive Form (ZIF).

ZIF has a special place in the study. It was the software that was used almost in every lesson during the experiment in the experimental group for teaching, practicing, doing puzzles, fulfillment of activities, assessment and other purposes. The researcher participated in the development of this software together with Zambak Publishing Company's programmers. All activities of the lessons were held through ZIF. There are many activities in the software. These are: matching activity, animated lectures, fill-in the blanks, true-false activity, pictures, videos, puzzles, animations, sliding activity and free sliding activity. All these activities were used in different parts of the classes. For example, matching activity is used for practice, learning, fun and assessment.

All software has some advantages and some disadvantages. Some educational software offers only ready-made activities which may not fit the course book and the curriculum applied. Others require from the teacher to develop his own activities and materials, using the software.

ZIF provides a rich choice of ready-made materials and tasks as well as the possibility for the teacher to develop his/her own materials.

Educational technologies offer educators a variety of new assessment tools that can be used inside or outside of the classroom. The researcher, to measure the learning outcomes of experiment participants, used different types of assessment methods from ZIF. It has got a special testing part, extra questions part, worksheets and quizzes.

The teachers need to keep in touch with parent as well as students. SIS (Student Information System) can be used to inform parents about students' grades, home tasks, and behavior problems (if such exist). Internet e-mailing systems and social media, like Facebook and Edmodo, helped to communicate with the students. Also, the researcher uploaded presentations of the lectures via the same tools, to enable students to revise the materials, if needed.

The activities with technology applications are divided into two parts: inside and outside the classroom. For the inside activities different types of activities should be used for different types of lessons (lessons for development, review and drilling). All these types of lessons have different goals and, to satisfy these goals, various activities are needed, such as:

- for development lessons: animated lectures, videos, animations, pictures, sliding, free sliding and matching activities.
- for review lessons: pictures, free sliding, sliding, matching, fill-in-the-blanks, true-false activities, puzzles and test maker.
- for drilling lessons: pictures, free sliding, and sliding, matching and fill-in-the-blank activities.

The activities fulfilled outside the classroom lesson (in school computer lab or at home) are online activities and they generally the include use of the Internet, especially, social media.

An important component of the technology is software. There are different criteria for selecting effective software. Checking the market shows that there are thousands of different software and web sites, but it is important that teachers know which of them are effective and which of them are a waste of time. Jackson (2000) said that there are two ways to select the best program; one is to trust the guides to software and portals to websites (which all look like twins and many descriptions are not trustworthy) and the second is to undertake one's own assessment. So, the researcher worked out a list of criteria to select effective software and checked the used software by these criteria. Among the software assessed only ZIF satisfied all of them. The criteria include the following items:

1. Teachers can add their documents and materials.

2. It should be suitable for smart board.

3. Is should be useful for teaching.

4. It must include multimedia documents.

5. It must be relevant to the curriculum.

6. It must be attractive for students.

7. It must include everything in one place.

8. It must be ready to use.

9. It must include different activities with feedback.

10. It should be free or cheap enough.

Preparation of lessons with the application of technological devices may take a long time, but using these devices free a lot of time during the lesson for more interesting and creative applications.

The efficiency of application of technology greatly depends on classroom management. The aim of the classroom management is to maintain a positive and productive learning environment. It involves effective planning, teaching methods, timing, organizing the classroom environment, student involvement and discipline. To manage all of these teachers need more time. The use of technological devices requires time for preparation, but saves time from mechanical work at the lesson. It is not a secret that disciplinary problems arise if students are bored and/or do not understand the material. Work with technology application should be held in different formats: as individual, pair, small (3-4 students) groups or whole-class. While students are working in groups, their functions should be distributed, to provide everybody's involvement. Brainstorming may be an efficient activity for algebraic problem-solving. Teachers' Resource Kit and ClassDojo are beneficial programs that help teachers in dealing with classroom discipline.

At the end of second chapter some advice for administrators and heads of departments is given. Teachers need support, better technological devices, training courses and seminars and suitable classroom sizes. Also they need collaborative work for preparing educational materials, finding suitable and effective software, holding and participating in special seminars for mathematics teachers, being organized in groups to discuss together with colleagues particular cases/problems they are facing.

Figure 1 summarizes all the components of the used model of management strategies for applying educational technologies while teaching algebra. The first level of the model includes three parts: technological devices, software for these devices and activities used in the software. The criteria to select all these components were introduced in the second chapter. On classroom

and homework management level of the model, technological devices, software and activities for individual, pair and group work are presented. The finalizing level includes the assessment of students' learning outcomes. Both formative and summative assessment was used; besides, some questionnaires and informal interviews are applied, to see whether the educational process was really efficient.

CHAPTER 3: METHODOLOGY AND RESEARCH

This chapter covers the components of the research. The study focused on the impacts of using the technological devices and the selected software in algebra lessons. After proving the benefits of using technological devices and software, the researcher investigated the teachers' beliefs on the use of technology in mathematics classrooms. Later, the barriers and managerial solutions of the teacher's use of technology were investigated. Finally, teacher's use of technological devices and software for algebra lessons was checked.

Both qualitative and quantitative research have some advantages. This study uses a mixed approach, both quantitative and qualitative perspectives, to prove the hypothesis and to answer the research questions. But the main emphasis is on quantitative perspective. Besides, this study includes some components that are used in case study researches.

The participants of the study were the students from Private Demirel College, 10th grade. After all 53 ten-graders wrote the pre-test, which showed that their algebraic skills were on the same level in 10-A and 10-B class, while averages of 10C were very high, the researcher at random selected 10-A as the control group and 10-B as the experimental group. The equal level of algebraic skills made the groups comparable to each other and, correspondingly, experiment results trustworthy. In 10-A there were 8 girls and 9 boys (totally 17 students) while in 10-B there were 7 girls and 13 boys (totally 20 students), so finally 37 students participated in the experiment. The ratio of female and male students did not differ too much (in learning mathematics this is important, as boys are believed to be better mathematicians than girls).

Participant bias occurs in experiments when participants adjust their behavior to what they think the experimenters expect (single blind control). The researcher used double blind control. The students knew that an experiment was going on, school administration and parents, as well as the students consented to participate in it, but neither the students, nor the teachers involved knew the essence of the experiment. Students also were informed that experiment results would not have an impact on them and would be anonymous.
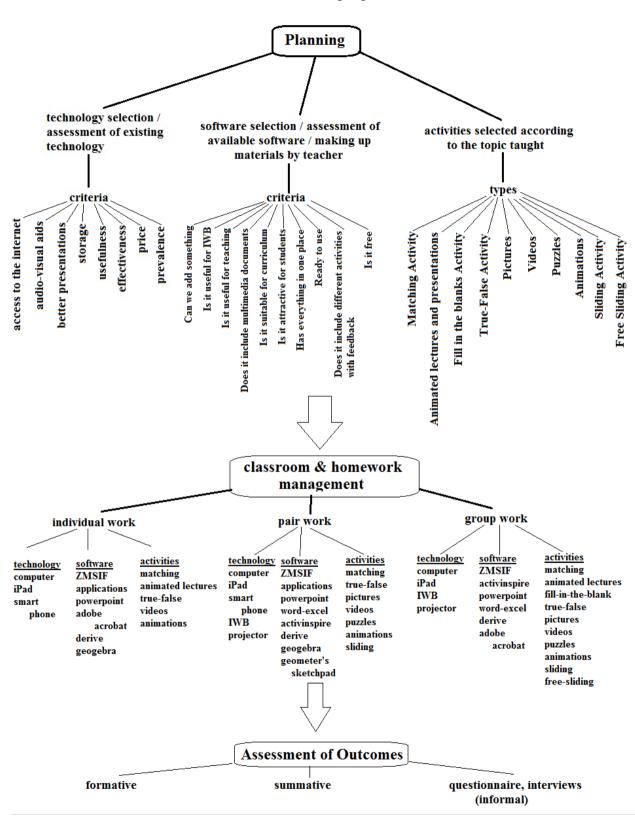
Figure 1. Model of management strategies of using educational technologies by school teachers while teaching algebra

The model of teaching algebra was used in 10-B class for 3 months to teach algebra. The other teacher taught the same topics, by using the same course book and the same curriculum, but without using the suggested model (they even sometimes used technologies, not to make the goal of research obvious).

The research has one independent **variable** (method of instruction) and 4 dependent variables (mathematics achievement, attitude towards algebra, attitude towards technology-aided instruction and software, and the retention of the learned materials).

The data was collected from 10th grades of Private Demirel College in Tbilisi over a period from February 2015 to April 2015 (12 weeks, with 5 lessons a week). The tests and questionnaires were piloted in Almaty KTL for girls and in Private Demirel Collage's 10-C class.

Data were collected via 3 algebra achievement tests. These are: a pre-test, a post-test and a retention test. The results of these tests were as follows:
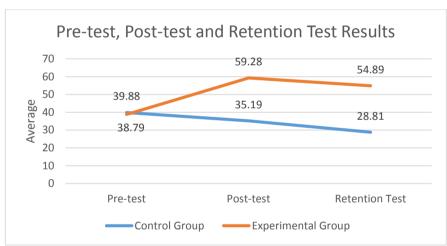
Figure 2: Pre-test, Post-test and Retention Test Results

The decrease in the mean results of the control group is visible. On the other hand, the mean results of the experimental group increased substantially from the pre-test to post-test. But in retention test there is a small decrease in the mean, but this decrease is not as much as the decrease of the control group and the results of the retention test are still perceptibly higher than in the pre-test, which proves not only higher learning outcomes, but also the durability of the acquired knowledge and skills.

The second group of data was collected from two attitude questionnaires. The first questionnaire was performed to assess the initial attitudes of the students towards algebra and their beliefs about the importance of mathematics lessons. The reason for holding the second

questionnaire was comparing the changing attitudes of the students towards algebra lessons and the used software.

Table 1: Mean results of Questionnaires for Students

CLASSES	Mean of 1.Questionnaire	Stnd. Dev.	Mean of 2.Questionnaire	Stnd. Dev.
10 – A (Cont. Gr)	2.90	0.22	2.93	0.55
10 – B (Exp. Gr)	2.88	0.25	3.48	0.76

The results of questionnaires were tested by Cronbach's Alfa Test and reliability of total questionnaires was found good.

The mean results of the second questionnaire for 10-A class (the control group) is similar to the average of their first questionnaire. That means that there is no important change in their attitudes towards algebra lessons. On the other hand, the mean results of the experimental group increased from 2.88 to 3.48 (a 12%-increase). This result shows that the teaching model applied has a remarkable effect on the attitudes of the students.

The third group of data was collected from mathematics teachers: 247 teachers from 18 countries including Georgia, Kazakhstan, Turkey and Indonesia. The aim of this questionnaire was to investigate the beliefs of teachers about the use of technology in algebra lessons. The total mean of the questionnaire reached 4.24 (out of 5 Likert scale points). The results were tested by Cronbach's Alfa Test and their reliability was found good.

The results showed that teachers believe that integrating technology into education and especially algebra lessons has many advantages; it increases the achievement and motivation of the students, and has a positive impact on the attitudes of students towards mathematics lessons. By using technology teachers may use different teaching methods and help more students, they may use the student-centered education, increase the retention of the learned topics. The usage of technological devices is not so difficult, but it has advantages for both of the students and the teachers. Teachers feel more comfortable in the lessons when they use the technology and they manage the class better with the help of technology.

The second questionnaire for teachers was prepared to assess the current technology integration in the classrooms, the abilities of teachers related to use of technology and their expectations from the administrators and the heads of departments. There were 12 questions, three of the questions were check-box and other 9 questions were open-ended questions. The

data were collected from 126 teachers from 13 countries including Georgia, Kazakhstan and Turkey.

It is found that more than half of mathematics classrooms are technologically well equipped, but teachers need some seminars and courses for using the technology efficiently. They have got many expectations from the administrators: support, better devices, seminars and courses, effective software, solutions of technical problems, forming collaborative working groups, etc. They learned how to use the technological devices by themselves, but need to develop their skills.

There are certain barriers for some teachers to use technology: the lack of technological devices, or outdated devices, time pressure, lack of technical support, effective software and of relevant skills. In general, teachers believe in the advantages of using technology. Also, the most responsible person for their application are the teachers and administrators.

The third questionnaire for teachers investigated the teachers' beliefs about the most effective technological devices in teaching and learning, the abilities of the teachers for using the technological devices and developing educational software, the most useful software for mathematics lessons, the properties of an effective educational software for teaching algebra, the names and reasons to select the software for their lessons and their ideas about ZIF.

It was found that the most useful device for teaching is smart board, while for learning - computers. Teachers generally know how to prepare the basic educational materials, but many of them cannot develop software or computer-based materials. Many teachers use ZIF and characterize it as very effective software for teaching mathematics.

It is not enough to install technologies in the algebra classes, it is also not enough to use them somehow. It is needed to work out a model that will involve all levels of technology application, then the application of technology will really be efficient. The researcher, based on experiment results, dare say that the model developed by him is an effective one and can be recommended to other teachers for application.

All of the benefits of technology application are connected with the teachers' ability to use it efficiently. If they believe in the effectiveness of the technology, they will solve all of the problems related to the technology integration. So, the most important thing is to teach the teachers to use the technology. After this we can expect the benefits of technology.

CONCLUSIONS AND RECOMMENDATIONS

Throughout the study, the researcher got some valuable results from the experiment in school, literature review and questionnaires for both students and teachers. By looking at these results, conclusions will be drawn and recommendations can be given to teachers.

This part includes the research questions and the answers to them.

1. Is there a considerable difference in the pre-test results of the experimental group and control group students?

   No. The pre-test result of the control group was 39.88 and of the experimental group was 38.79. There is only 1% of difference, and it can be ignored.

2. Is there a considerable difference in the post-test results of the experimental group and control group students?

   Yes. There is a great difference between the mean post-test results of the experimental and the control group. The mean result of the control group was 35.19, while the mean result of the experimental group is 59.28.

3. Is there a considerable difference in the retention test results of the experimental group and control group students?

   Yes. The retention results of both groups was decreased to a certain degree, but this decrease is greater in the control group (18% for the control group and 7% for the experimental group).

4. What are the expectations of the teachers from school administrators to support the use of technology at their lessons?

   - Any type of tangible or intangible support.

   - Training courses and seminars to learn effective usage of the technological devices.

   - Administrators must be open-minded for educational technologies.

   - Administrators should be interested in the quality and sufficiency of the lessons, not only managing the school.

   - Better devices for their classrooms.

   - Technical support for their technological devices.

5. What are the expectations of the teachers from the heads of departments to support the use of technology in their lessons?

   - Any type of tangible or intangible support.

   - Effective software for lessons.

   - The heads may distribute the tasks to teachers and collect all prepared materials to share with all members of their department.

- They need to prepare their curriculum and syllabus by integrating efficiently educational technologies.

- They need to select the course books which have got more technology support.

- The heads should train some expert teachers who, in turn, will train new teachers to use technological devices and mathematical software.

6. What are the properties of effective educational software?

- Everything in one place

- Compatible with the IWB

- Includes visual aids and multimedia materials

- Easy to use; its' user interface should be clear and useful.

- Includes many examples; solved or unsolved, classical or multiple choice, …

- Satisfies all teachers' and students' needs; involves videos, questions' numbers and types, prepared exams, pictures, etc.

- contains 3-D illustrations of the topics

- Includes real-life applications of the given topics

By using the answers of sub-questions and other components of the study the researcher obtained the following answers.

The first question was "Is there any impact of the use of technology in algebra lessons for the achievement, motivation, retention and attitude of students towards algebra?".

It is found that the suggested model of teaching algebra with the help of technological devices has a meaningful and positive effect on the achievement of the students in algebra lessons. The students understand algebra lessons better when they are taught by using the technological devices with relevant software. It was found that the use of the suggested model increased the achievement of the experimental group from 38.79 to 59.28 (about 21%).

It is also found that the used model in the study had a positive effect on the retention of learned topics comparing with traditional methods of teaching. While the retention test results of the control group decreased by 18%, the experimental group's results decreased only by about 7%.

The strategic use of technologic devices and effective software changes the attitudes of students towards mathematics lessons. The results of student's questionnaires showed that attitudes of the students towards algebra classes in the control group increased only by about 1%; on the other hand, the attitudes of students in the experimental group increased by about 21%.

That means that the model of teaching algebra in the study has a meaningful positive effect on the attitudes of students.

The use of technological devices and relevant software make students more active at the lesson. Also, technology-integrated lessons are more attractive for students. Students understand algebra better with technology integration. The application of software in the study makes algebra lessons more enjoyable for the students. The software helps teachers to form competitive and collaborative classroom environment and it makes the lessons more attractive for both teachers and students. Students think that some entertainment and enjoyment in algebra lessons does not make them worthless. The use of various technological devices and relevant software in all parts of the education and management system make schools more attractive and efficient for students. Teachers can bring authentic materials into classroom environment and in this way they can attract students' attention and increase their motivation. It is observed that the use of technology in teaching algebra increases students' motivation. Because of this, it is recommended to administrators to use technological devices and corresponding software in all parts of their schools and support their teachers in using them efficiently.

The second question was "What is the effective model of teaching algebra in high school with educational technologies?" The results of the experiment showed that the suggested by the researcher model of teaching algebra is an effective one. That means an effective model should provide alignment on all levels:

- It should apply different types of technological devices: computer, IWB, projector, iPad and smartphone, according to the task to be fulfilled.
- Software should be compatible with these devices.
- There should be different activities in this software that attract students' attention. Also, these activities should help teachers to form a collaborative and competitive classroom environment. The model should demonstrate the parts of the lesson when different software and corresponding activities are used.

Although students believe in the importance of algebra, some of them do not like the subject. If a student or a teacher does not like the lesson, it is very difficult to learn or to teach. It is recommended to teachers to pay special attention to such students and show them the enjoyable and practically useful aspects of mathematics. They should use more exciting activities, such as puzzles or mathematical games. By making some changes and using effective models teachers can make their lessons more attractive for the students and decrease the anxiety of students.

The third question was "Which technological devices and software can be used in algebra lessons?"

The results of the study showed that many technological devices can be used in algebra lessons. Their effectiveness is directly related to teacher's pedagogical and technological skills. Teachers may use computer-projector-IWB during the lessons. After lessons they may use and advice the students to use iPad, tablet PC and smartphone. IPads and smartphones are important components of continuous education. Students may carry these devices everywhere and can start the applications quickly.

Every technological device has some advantages and some disadvantages. Educators need to assess the capacities of technological devices before integrating them into educational process. If the advantages are more than the disadvantages of a particular device, teachers can integrate that device into a lesson or students' independent work.

There are much useful software for teaching algebra. Teachers may use them in the lessons. But, before using the software, they need to define some criteria and by looking at these criteria teachers can select the most useful software for algebra lessons. This study showed that ActivInspire, Microsoft PowerPoint, Word, Excel, Adobe Flash are useful general-purpose software that may be used in algebra lessons. Besides, teachers can use some software which are prepared specially for mathematics. Some of them are Geometer's Sketchpad, MathType, Derive and Geogebra.

This study also showed that ZIF is efficient software for teaching algebra. The majority of the involved teachers believe in the importance of using software for teaching algebra, and many of them select ZIF as the most efficient software for teaching algebra. ZIF has a lot of advantages for teaching algebra, so the majority of the teachers are satisfied with the properties of ZIF. It was developed by a team of teachers and programmers, includes many types of activities, is easy to use for teachers and students, can be used by students for self-study, includes all types of multimedia files (sounds, pictures, caricatures, videos, anecdotes, web links and others), uses a dynamic screen, has a special testing program with a statistical result page and includes various question types (like fill-in the blank, true-false activities, puzzles, drag and drop activities, and others).

The fourth question was "How can we select or prepare effective educational software?"

Any teacher or educator may define their own criteria to select the best software for their lessons. In this study the researcher defined the following criteria to select efficient software for teaching algebra. These are:

- Can teachers develop their materials when needed?

- Is it useful for IWB?

- Is it useful for teaching?

- Does it include multimedia documents?

- Is it suitable for curriculum?

- Is it attractive for students?

- Does it have everything in one place?

- Is it ready to use?

- Does it include different activities with feedback?

- Is it free or cheap or at least cost-effective?

Educational software should be prepared by a team including some educators and some programmers. Because of this, it is recommended to educational faculties to give some elective courses to teach the development of educational software.

This study is a quantitative research which includes some elements of qualitative researches. Because of this, some more conclusions were obtained from the experiment and teachers' questionnaires. These conclusions and related recommendations are listed below.

The students have always some awareness of algebra exams. In classical (on-paper) exams they may write something on their paper and teacher gives at least a few points for their writings, but the technology-based exams expect exact answers from the students. Because of this, it is harder to get a better mark from a technology-based exam. But technology-based exams are rather reliable and valid compared with on-paper exams. Also, checking the exams by using the technology is very simple and fast. So, the researcher recommends all teachers to use technology in the exams, but try to decrease the anxiety of students.

The study showed that students do not accept technology as main part of education. It helps teaching, but cannot substitute teachers.

It is found that the majority of mathematics classrooms, especially in private schools, has an acceptable amount of technology integration, but at least 30% of the classrooms still need more technology integration. Also, the quality of the technological devices must be improved. Technological devices without relevant contemporary software are not too useful. So, it is

recommended to the heads of departments at schools to develop or find the best software for these devices.

The study showed that many classrooms have IWBs but almost half of the teachers are not using their full potential and properties. They are using IWB like a marker board and for Power Point presentations. Also, teachers know the benefits of technological devices and are ready to use any existent device in their lessons, but they may need to develop their skills to use these devices effectively. So it is recommended to administrators and heads of departments to initiate some seminars and courses for teachers to teach the properties of technological devices and suitable software.

An important concern is related with the quality of existing devices. Many classrooms need better devices. It has been found that lower quality outdated devices have more technical problems and it affects teachers' motivation. The fear of technology is mainly caused by technological devices which are not user-friendly. For this reason, the researcher recommends the administrators to get the most relevant devices and software for their schools.

Teachers believe that technology integration is teachers' duty. If teachers want, they can learn to apply technology from more experienced in its application teachers, from courses or from other sources like internet. So, it is recommended to administrators that they should motivate teachers to use technology, and to do so efficiently.

Education faculties / programs need to add to curricula courses dealing with theoretical and practical issues of effective usage of technologies. The majority of teachers can develop basic educational materials for their lessons, but only a few percent of them can develop educational software or at least materials with the help of special software for teachers. So, the researcher recommends educational faculties / programs to have elective courses for teaching development of software and computer-based educational materials.

There are a lot of barriers to integrate the technology into classroom environment. The most important barriers are:
- Lack of technological devices
- Lack of time for preparation
- Lack of technical support
- Lack of skills of using devices
- Lack of suitable software
- Curriculums of ministry of education

- Lack of support from the administrators

- Unsuitable number of students in a class

- Low teacher's motivation

The study showed that the strategic use of technological devices and effective software has many advantages for both students and teachers. It:

- Helps to save time at the lesson.

- Is attractive for students.

- Helps teachers in classroom management.

- Technological devices are more visual and they make lessons easier to understand.

- They offer a variety of examples and teaching methods.

- Enables to reach additional resources easily.

- Offers different learning methods for different types of learners.

- Activates more senses of the students and increases the quality of education.

- Help students in character formation.

- Increases the interaction between the students and teachers.

- Increases the creativity of the students.

- Prepares students to the future.

Teachers believe that the most efficient technological device for teaching is IWB and for learning is computer. But an IWB, a projector and many other technological devices need a computer to perform. So, we may accept the computer as the most important component of the educational technologies. It is recommended to administrators to have at least computers in their classrooms, but the more technology there is, the better.

It is recommended for administrators to use the strategies listed below to integrate the technology into education system:

- Use better devices in the classrooms.

- Use verbal and tangible support to the teachers to make them use more technology integration.

- Support teachers by organizing seminars and training courses for technological devices.

- Set up collaborative working environment for teachers and support them to share their products with other colleagues.

- Be open-minded towards technological developments and pay attention to teachers' demands related to technology integration.

- Employ experts to solve technological problems and to teach the use of technological devices.

- Try to find the most effective software for the technological devices at hand.

- Try to make everything easy at school with the help of technology.

- Encourage the teachers to use technology in their lessons.

- First impression of teachers towards the technology has crucial importance. So, try to find the best technological devices and the most effective training courses for teachers.

- Form your classrooms with adequate number of students.

- Use reward-punishment. Reward can be a tangible object or money or just thanks at an official ceremony, but punishment should not deal with money. The punishment may be taking the technological devices away from the classes of the teacher who cannot use them effectively and give them to another teacher who uses the devices more effectively.

The major research findings of the dissertation are presented in the following publications:

1. Çakir, A. (2015). Effects of using interactive whiteboards at high school mathematics classrooms. *Journal of Education*, 4(1), 17-23.

2. Chakir, A. (2016). Beliefs of teachers about the integration of technology into mathematics lessons. СДУ ХАБАРШЫСЫ, 3(34), 101-116.

3. Çakir, A. (2016). Impact of effective educational software on teaching mathematics (Case study of application of Zambak interactive form). Journal of Education in Black Sea Region, 1, 2, 25-45