PROCEEDINGS

of the Union of Scientists - Ruse

Book 5

Mathematics, Informatics and Physics

Volume 8, 2011

RUSE

ISSN 1311-9974

The Ruse Branch of the Union of Scientists in Bulgaria was founded in 1956. Its first Chairman was Prof. Stoyan Petrov. He was followed by Prof. Trifon Georgiev, Prof. Kolyo Vasilev, Prof. Georgi Popov, Prof. Mityo Kanev, Assoc. Prof. Boris Borisov, Prof. Emil Marinov. The individual members number nearly 300 recognized scientists from Ruse, organized in 13 scientific sections. There are several collective members too – organizations and companies from Ruse, known for their success in the field of science and higher education, or their applied research activities. The activities of the Union of Scientists – Ruse are numerous: scientific, educational and other humanitarian events directly related to hot issues in the development of Ruse region, including its infrastructure, environment, history and future development; commitment to the development of the scientific organizations in Ruse, the professional development and growth of the scientists and the protection of their individual rights.

The Union of Scientists – Ruse (US – Ruse) organizes publishing of scientific and popular informative literature, and since 1998 – the "Proceedings of the Union of Scientists- Ruse".

BOOK 5

"MATHEMATICS, INFORMATICS AND PHYSICS"

VOLUME 8

CONTENTS

BOOK 5

"MATHEMATICS, INFORMATICS AND PHYSICS"

VOLUME 8

Education

Participation in International Projects

TEACHING AND LEARNING MATHEMATICS BASED ON GEOGEBRA USAGE

Magdalena Petkova, PhD student

Angel Kantchev University of Ruse

Abstract: *The paper presents conditions and results of studies which determine the necessity of using computer technology, particularly GEOGEBRA in teaching and learning of mathematics.The results of a pilot study are presented concerning the attitudes of teachers in mathematics from Ruse for deeping learning of GEOGEBRA and its future application in teaching and learning processes. The study includes the training of 16 teachers in mathematics from different schools.*

Keywords*: GEOGEBRA, teacher education, mathematics.*

INTRODUCTION

The development of the technological postindustrial societies in countries like USA, Japan, Korea, Iceland and others, creates the need of skills for learning throughout the entire life, based on knowledge and skills in using computer and information technologies.

The preparation of teachers in mathematics, which is to be in compliance with the modern need of the public, demands the development of skills for appropriate usage of modern day technologies in the study of mathematics. Influenced by companies like CASIO, who develop educational software, researchers in the field of teaching and learning mathematics, math teachers in schools and lecturers at universities pointed their attention to the usage of:

- Numerical and graphical calculators;
- Computer Algebra Systems (CAS), aimed at simulations with symbolical expressions like Derive, Maple, Matematica;
- Dynamical Geometry Software (DGS), based on the relations between geometrical objects like Cabri and Sketchpad.

In the process of using them the two formats CAS and DGS are being perfected and turned into comfortable products, which are easily used to solve a variety of mathematical problems – the forms of CAS contain possibilities for visualizing mathematical objects and ratios and DGS contain elements of algebra representation.

The software GEOGEBRA [3] combines many of the possibilities of the two formats CAS and DGS, for instance the equations and coordinates of points can be entered directly, graphically with the mouse or algebraically through the entering of algebraic values. Analogically the functions can be defined algebraically and then altered dynamically by changing the graphic.

The training of teachers in Bulgaria in using GEOGEBRA in teaching mathematics corresponds with the public educational goals.

THE BENEFITS OF USING CAS & DGS

Research in the usage of CAS & DGS as tools in teaching mathematics shows them as a base for developing theoretical models aiming the usage of technologies in the study of mathematics. For instance, the K. Ruthven model is created on the basis of a study on the application of CAS systems in teaching mathematics [11]. The research confirms the usage of technologies in the learning process:

- Increasing sufficiently the effectiveness of content performance;
- Helps the creation of good learning conditions for students in the classrooms.

Another research of K.Ruthven [12] on the role of digital technologies and resources in the improvement of processes of testing skills concluded that these technologies help to:

- Increase the speed and efficiency in presenting the academic material;
- Make the presentation more diverse and interesting;
- Provide conditions for changing the way of learning – introduction of elements of games, fun and excitement;
- Motivate and stimulate the students to learn.

The research of A.Carle, D. Jaffee and D.Miller shows that the usage of computer based technologies increases the motivation of the students for achieving higher goals [1].

The number of studies aimed at the usage of DGS in the learning process of mathematics is increasing. Jahn, A. & J. Salazar study the possibilities of exploring three-dimensional geometry using a dynamic geometry environment [4]. S.Soury-Lavergne studies the deductive reasoning, based on dynamic geometry using of CABRI 3D [13].

The researcher V. Kokol-Volich determines the possibilities of GEOGEBRA for the early development of geometrical concepts [6].

The project of P. Kenderov „Innovation in Studying Mathematics on an European Level“ [17] is aimed at forming basic knowledge in the usage of information technologies in the study of mathematics.

The rapid spread and development of GEOGEBRA verifies its efficiency in the teaching of mathematics [15].

On one hand it’s important the teachers and the pupils to develop themselves as users of CAS & DGS technologies, with which they can create new knowledge, solve tasks, simulate processes, prove hypotheses, explore objects, develop models. On the other hand, the students must also use CAS & DGS technologies in the right time, in the right conditions for the correct learning and disciplinary objectives.

GEOGEBRA USAGE IN TEACHING AND LEARNING MATHEMATICS

GEOGEBRA was designed by M. Hohenwarter at the University of Salzburg, Austria [3]. It connects the basic principles of mathematics study and those of usage of computer technologies in the education process. GEOGEBRA uses dynamic geometry, algebra and elements of mathematics analysis. With it an user can create:

- constructions of points, vectors, circle segments, segments, etc.;
- functions which later can be dynamically changed by the usage of a mouse.

The most important characteristics of GEOGEBRA is its ability for a dual presentation of objects: every string in the algebraic window output has its correspondent value in the geometrical one and vice versa.

GEOGEBRA is mathematical software and its features can be studied in the process of learning mathematics.

GEOGEBRA is freeware software, it does not require licensing, and this is one of the main reasons for its fast spreading and usage across schools and universities.

Many people believe that GEOGEBRA can be a motivating factor in the process of teaching mathematics and a useful tool for students throughout their education.

GEOGEBRA is suitable to be used for:

- research activity, where it is used on the basis of combining facts, experimenting with certain combinations, results analysis and hypothesis suggesting, creating models, confirming or withdrawing a hypothesis;
- simulations which aim to analyze possible solutions and many other..

The main purposes of the "Fibonacci - Disseminating Inquiry-Based Science and Mathematics Education in Europe" [16] project are the following ones:

- to vastly include the research method that is based on the usage of CAS&DGS and in particular on GEOGEBRA in the process of teaching mathematics and natural science;
- to help the creation and development of centers for qualification and pre-qualification for currently practicing teachers so that they start using the research method in teaching mathematics and natural sciences;
- to create materials and manuals for GEOGEBRA usage in the process of teaching mathematics.

Publications and studies that study different software products, including GEOGEBRA, can also be found on the European Virtual Library of Mathematics (EVLM) [14]. EVLM is a database of theoretical study materials, relevant case studies and information on software products, which help gaining knowledge and abilities to implement it in both the processes of teaching and studying mathematics.

Gaining knowledge to work with GEOGEBRA when teaching is a necessary step in the development of the professional qualification of teachers in mathematics.

EXAMPLE OF CURRICULUM CONTENT FOR LEARNING GEOGEBRA

After an analysis on the usage of CAS & DGS as a mean for rising the efficiency of the learning process and the need to enrich the standard methods of mathematics teaching, a National Programme for Development of School Education and Preschool Education since 2006 to 2015 was created [9]. The aforementioned Programme is designed to encourage the integration of ITC technologies in education systems.

The main benefits of the Programme are connected with:

- enlargement and enrichment of the sphere of study by means of interactive methods and strategies for teaching and studying;
- improvement of the existing static forms of study materials and creation of dynamic (multimedia) materials, which integrate image, sound, animation and text;
- usage of electronic and multimedia study materials through education process.

The integration of educational mathematics software is set towards the development of abilities for effective knowledge management but not towards providing knowledge of the technology itself.

The expectations are set towards a positive change in both teachers and students' attitudes to the usage of ITC technologies in the process of mathematics teaching and studying and towards the development of students' abilities to create and work independently in an integrated approach towards the educational process.

The process of every study material unit development (lesson, problem, solution, analysis etc.) based on GEOGEBRA integration in mathematics teaching is connected with:

- an analysis of the basics of the national standards for curriculum in mathematics;
- determining the areas and subjects which allow integration of new knowledge and skills;
- determination and argumentation of deductive work technologies and the active methods of education;
- determining the routine and the creative cognitive activities of students;
- determining the tasks to be individually or cooperatively performed by the persons who studies and their teachers;
- others.

On the basis of the aforementioned the need of qualification and pre-qualification of teachers and lecturers which is aimed at updating their knowledge arises [9].

There are four main stages of gaining knowledge and skills to use and integrate GEOGEBRA in mathematics teaching. Those four stages are:

- First stage: Forming interest in the software by presenting its characteristics (main menus, submenus, tools) and mathematical problems, which require simplified geometrical drawings and constructions. A short manual is written to explain and instruct on this stage.
- Second stage: Teaching how the basic commands to be used through the development of samples added to the main education content Beginners manual creation, which contains all commands along with relevant examples, GEOGEBRA, drawing short sample math problems with the participation of the students.
- Third stage: Students' working independently on creating study materials by using GEOGEBRA. Results presentation in front of a suitable and relevant audience. Website's creation containing study materials and manuals and guides for advanced learners.
- Forth stage: Teaching based on methods for teaching and learning mathematics by using GEOGEBRA. Knowledge showing and testing in a real study process and results evaluation by experts from the GEOGEBRA Institute, Ruse, Bulgaria.

As a summary, studying GEOGEBRA by students in mathematics requires forming and developing knowledge for creating and using study resources in the educational process.

PILOT STUDY ON LEARNING GEOGEBRA

Public expectations guide the efforts of researchers to study:

- The role of technology in teaching, for example, to increase motivation to learn [1, 10].
- Benefits of integrating technology in teaching [5];
- Critical points in mathematics [5] and others.

However, there are studies which show that:

- Many trainers are convinced of the necessity and benefits of implementing technology in teaching, but do not use them [8];
- Many learners use technology to record lectures and instructions for exercises, etc... However, not for effective teaching [3].

These results, on one hand, and the offer of the senior expert in mathematics and informatics in RIO Ministry of Education and Science Mrs. Diana Milanova, to organize training on learning GEOGEBRA, on the other hand, directed me to conduct a pilot study.

The main objective of the research study was the attitude of teachers in mathematics from Ruse to the thorough study of geometric software GEOGEBRA and its future application in teaching and learning of mathematics.

Current tasks for achieving the objective are:

- To implement the first stage model for studying GEOGEBRA as a convenient tool in learning mathematics.
- To explore the views of participants on the thorough study of GEOGEBRA for the development and use of educational resources in mathematics.

The study involved 16 teachers of mathematics and students from fifth to twelfth grade from different types of schools: Secondary Schools, High School in European

Languages, German Languages School, Vocational School in Electrical and Electronic Engineering.

Students were motivated to participate in such training for several reasons:

- There are many GEOGEBRA institutes that distribute this software vault, organize scientific and practical conferences, develop and disseminate educational materials on algebra, geometry, etc....
- In 2010 training on GEOGEBRA was conducted by a team of the Fibonacci project.

Research Methodology:

1. Quick guide was developed with technical characteristics of GEOGEBRA, instructions for installing the product, main menus, sub menus, tasks with simple drawings.
2. A system of tasks was developed for opportunities to integrate GEOGEBRA as a tool for visualization and simulation in teaching specific mathematical topics to support the formation of knowledge and skills of students.
3. A questionnaire was developed relevant to the purpose and objectives of the study.

The survey results are as follows:

How useful was your training in GEOGEBRA (Fig. 1)?

Did the training fulfill your expectations (Fig. 2) ?

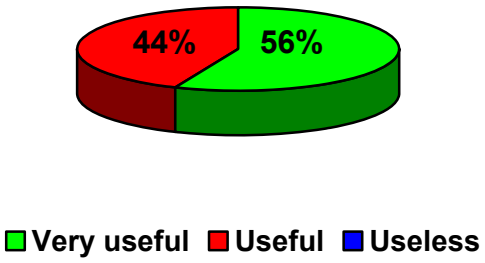


Figure 1

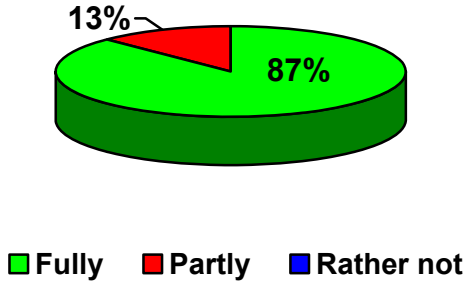


Figure 2

To what extent do you feel prepared after the training (Fig. 3)?

What is the probability after the training to use the acquired knowledge and skills (Fig.4)?

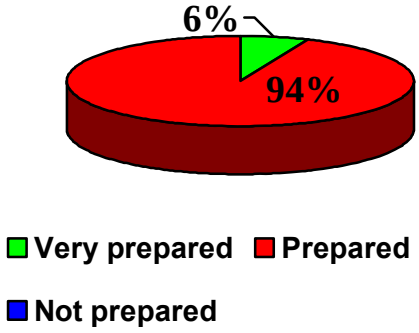


Figure 3

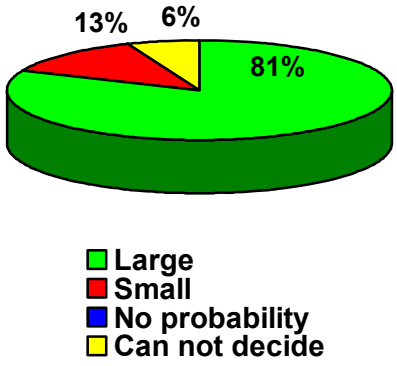
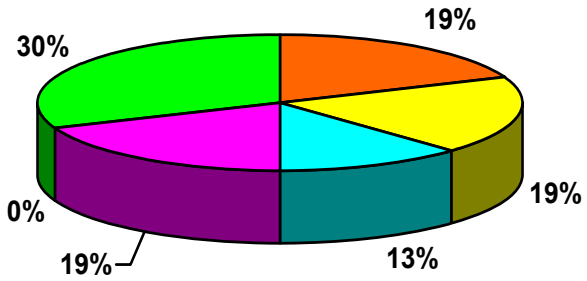


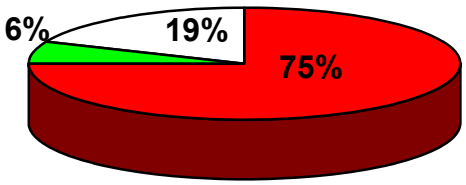
Figure 4

What skills did you acquire as a result of the training?



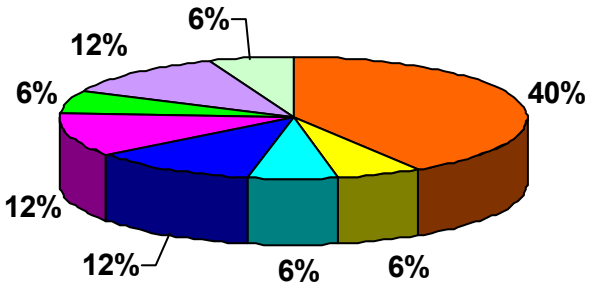
- Skills to create figures.
- Skills to introduce algebraic expressions.
- Skills constructs
- Skills for plotting functions.
- No special skills.
- Can not decide.

Do you think you need additional training?



Yes No Can not decide

What is your general impression of the training, in which you participate?



- Very good
- Excellent
- Positive
- I am satisfied.
- I like it. It is available.
- On good level.
- I would like sequel.
- The hours to be synthesized in two days.

CONCLUSIONS

The pilot study shows that:

- All participants are actively involved in learning software GEOGEBRA and believe that it is useful for their activities.
- The training motivates participants to continue their education, although 94% of them think they are prepared for its application in mathematics;
- The participants wish to develop their knowledge and skills to a level of development and implementation of educational resources in teaching and learning of mathematics with GEOGEBRA.

Therefore, it is necessary to be prepared training materials in GEOGEBRA as a basis for the teaching of students - future teachers of mathematics and for the qualifications of the existing teachers in mathematics teaching and learning mathematics using GEOGEBRA.

REFERENCES

1. Carle, A., D.Jaffee & D.Miller, Engaging college science students and changing academic achievement with technology: A Quasi-experimental Preliminary Investigation, Elsilver, Computers & Education, vol. 52, issue 2, 2009. p. 376–380.
2. Hermans, R., J.Tondeur, J.van Braak & M. Valcke The Impact of Primary School Teachers' Educational Beliefs on the Classroom Use of Computers, Computers & Education, vol. 51, issue 4, 2008, p.1499–1509.
3. Hohenwarter, M. and K. Jones Ways of Linking Geometry and Algebra: the Case of *GEOGEBRA,* BSRLM Geometry Working Group, Proceedings of the British Society for Research into Learning Mathematics, vol. 27, 3 November, 2007.
4. Jahn, A. & J. Salazar Exploring Three-dimensional Objects through Dynamic Representations Using *CABRI 3D*: An Experience with Brazilian School Students, Proceedings of the ICME 11, DG 22 New technologies in the teaching and learning of mathematics, Monterey, Mexico, 2008, www.icme11.org
5. Kim, M. & Hannafin, M. Scaffolding problem solving in technology-enhanced learning environments (TELEs): bridging research and theory with practice. Computers & Education, vol. 56, issue 2, 2011, p. 403–417.
6. Kokol-Voljc, V. Use of Mathematical Software in Pre-Service, Teacher Training: The Case of DGS, University of Maribor, Slovenia, Proceedings of the British Society for Research into Learning Mathematics, 27,3, November 2007.
7. Körtesi, P. Leonardo da Vinci Project European Virtual Laboratory of Mathematics, University of Miskolc, http://www.uni-miskolc.hu/evml
8. Liu, S.-H. Factors Related to Pedagogical Beliefs of Teachers and Technology Integration, Elsilver, Computers & Education, vol. 56, issue 4, 2011. p. 1012-1022.
9. National Programme for Development of School Education and Preschool Education from 2006 to 2015, www.minedu. government.bg (June, 2011)
10. Mann, B. The evolution of multimedia sound. Computers & Education, vol. 50, issue 4, 2008, p. 1157–1173.
11. Ruthven, K. & S. Hennessy A Practitioner Model of the Use of Computer-based Tools and Resources to Support Mathematics Teaching and Learning, Educational Studies in Mathematics, vol. 49, issue 1, 2002. p. 47-88.
12. Ruthven, K., R. Deaney & S. Hennessy, Using Graphing Software to Teach about Algebraic Forms: A Study of Technology-supported Practice in Secondary-school Mathematics, University of Cambridge, Faculty of Education, Forthcoming Educational Studies in Mathematics, 2009, Volume 71, Number 3, 279-297

13. Soury-Lavergne, S. Deductive Rreasoning and Instrumental Genesis of the Drag Mode in Dynamic Geometry: A View of Instrumental Genesis Using CABRI 3D, Proceedings of the ICME 11, DG 22 New technologies in the teaching and learning of mathematics, Monterey, Mexico, 2008, www.icme11.org
14. http://www.fmi-plovdiv.org/evlm/(June, 2011)
15. www.geogebra.org (June, 2011)
16. http://www.math.bas.bg/omi/Fibonacci/index.htm (June, 2011)
17. http://www.math.bas.bg/omi/InnoMathEd/index.htm (June, 2011)

CONTACT ADDRESS
Magdalena Metodieva Petkova, PhD student
Department of Algebra and Geometry
Faculty of Natural Science and Education
Angel Kanchev University of Ruse
E-mails: mpetkova@uni-ruse.bg, magipetkova@ymail.com

ПРЕПОДАВАНЕ И УЧЕНЕ НА МАТЕМАТИКА, БАЗИРАНИ НА GEOGEBRA

Магдалена Методиева Петкова, докторант

Русенски университет „Ангел Кънчев”

Резюме: *Статията представя условията и резултатите от изследвания, които определят необходимостта от използване на компютърни технологии, в частност GEOGEBRA, за преподаване и учене на математика. Представени са резултатите от пилотно изследване на отношението на учители по математика от гр. Русе към задълбочено изучаване на геометричния софтуер GEOGEBRA и бъдещото му прилагане в преподаването и ученето на математика. Изследването включва обучение на 16 учители по математика от различни видове училища за изучаване на GEOGEBRA.*

Ключови думи*: GeoGebra, учители, математика.*

ISSN 1311-9974