GeoGebra as a motivational tool for teaching according new curriculum in Slovakia

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Abstract: *In this article we describe some activities which we propose to implement within the framework of Slovak GeoGebra Institute. We present new goals defined in new Slovak curriculum ISCED 3 for Mathematics at secondary schools. Several students' works those use the GeoGebra software (by the students of Pedagogy at Catholic University in Ružomberok) will become a concrete example for motivation during the educational process. At the same time, we suggest some project possibilities for research and application of the GeoGebra in the education and in the work with students – university students of Pedagogy or students at secondary schools. Finally, the engagement of teachers at primary and secondary schools in the GeoGebra teaching as a part of their lifelong learning will be discussed.*

Keywords: Computer Based Math Education, Method of Generating Problems, Slovak Curriculum ISCED 3, Motivation in Mathematics education, lifelong learning of Maths teachers.

Introduction

The information and communication technologies bring according Weigand & Weth (2002) new evolution and successive and meaningful integration to educational process. This is possible to see also in the new Slovak Curriculum ISCED 1, 2 or 3 for primary and secondary schools. This curriculum suggests giving during the education transversal topics (for example multicultural education – number systems, medial education – interpretation of graphs). These topics are possible to present not only in the classroom, but also in the computer room.

The curriculum defines also competencies in the using of information and communication technologies. The pupil

- has the base skills in the ICT as a condition for his later development,
- uses the basic methods of work with text and simple presentation,
- can create simple tables and graphs and work in simple graphical surroundings,
- can use ICT in learning.

According Weigand & Weth (2002) the new technologies bring new accent to some goals in the Mathematics education. Calculating and mechanical skills by the pupils are less important, but the skills of mathematical processing of the task, development of algorithms, interpretation of the task results, numerical experiments and work with graphical representations are more important.

Factors for using of ICT in education

According to Oldknow, Taylor (2003) we can identify at least three reasons for promoting the integration of Information and Communication Technologies (ICT) in Mathematics teaching in schools:

- Desirability: In terms of students, the use of ICT may stimulate their motivation and curiosity; encourage them to develop their problem-solving strategies. In terms of teachers, the use of ICT may improve their efficiency, release more time to address students individually, stimulate re-thinking their approach to teaching and understanding.
- Inevitability: Many fields of publishing have moved from printing to electronic form. This applies to conference proceedings, reference works such as encyclopaedias, small-circulation textbooks, special journals, etc.
- Public policy: In Slovak National Curriculum ISCED 1, 2 and 3 there is defined that Mathematics as a subject belongs to the group Mathematics and Working with Information.

ICT support in the teaching process:

a) Creation and processing of teaching documents by ICT users' tools,
b) Creation of educational presentations,
c) Creation of tests, examination of knowledge in the testing programs,
d) Evidence and evaluation of outcome of education, grades' evidence and grading,
e) Searching and acquisition of additional information sources for the education (e-textbooks, educational materials, applets presenting given concepts and theories),
f) Exchange of information and experiences among teachers with the help of the communication tools

Important aspect of ICT aided education is the visualization. For Mathematics education can bring:

- Effective approach while discovering the results, solving problems and discovering the very structure of the model,
- Visualisation of relations and sequentialities in one model allows to deduce new results in other areas and fields of Mathematics and other subjects in relationship with Mathematics,
- Supporting of mathematical competence and basic competences in science and technology; digital competence; learning to learn key competencies.

In last years it will be more used the open source software GeoGebra. Nowadays it is accessible in 50 language versions. This system joins together computer algebra system, dynamical geometrical software and spreadsheet. Big advantage is user´s friendly character

and possibility to create dynamical HTML WebPages with interactive pictures. Software is downloaded from the www.geogebra.org. Teaching materials developed by this software is possible to find on the GeoGebra Wiki. Its Slovak version is step by step created now and we have interest to cooperate in this developing process with teachers in schools, pupils and students – future teachers at universities. Some examples are possible to find also by Billich (2008), Tkačik (2007) and Wittmann (2008).

Cooperative learning in Mathematics education

Cooperative learning has got lots of applications in Mathematics and Informatics education. According to Jablonský (2006) this learning has five essential principles:

1. development of positive interdependence,
2. assurance of face-to-face promotive interaction,
3. strengthening of individual accountability and personal responsibility,
4. improvement of interpersonal and small groups skills,
5. reflection of group processing.

Nowadays there is this type of learning very important for development of social skills of pupils. Some educational projects such as building of teaching materials for GeoGebra Wikipedia is possible to realize in effective way only in the case if these materials are prepared by the groups of pupils.

The method of generating problems

According to Kopka (1997) many educators say that the main goals of teaching mathematics are:

- the development of logical thinking,
- the development of creative thinking,
- the development of an autonomous person,
- the development of the ability to solve problems.

GeoGebra allows to insert these goals in Mathematics education. The method of generating problems (see Wittman (2001)) seems to be suitable for this purpose (due to its systematically creating sets of internally connected problems). Student´s activities and instructions have to be regarded as complementary factors in the learning process. These factors both are necessary and must be systematically related to one another so that optimal progress may occur. The aim of our method is to create areas in which the students may–using the result of guided teaching–move as independently as possible, and in which he/she may develop their own initiatives. The student is considering his own problem and he could ask for help as far as it is necessary. By this way he can obtain basis for further work. After a problem has been completely solved and clarified the teacher together with students is thinking about further questions and generate problems which are related to the problem just solved. Thus the original problem acts as a generating problem; we will call it generator problem (GP). Related problems are obtained by analogy, variation, generalization, specialization etc. The group of all new problems together with their GP will be called the set of generated problems of the GP or the problem domain of GP. This method is possible to demonstrate with GeoGebra for example by the generator problem – Pythagorean theorem in grid paper (see Figure 1).

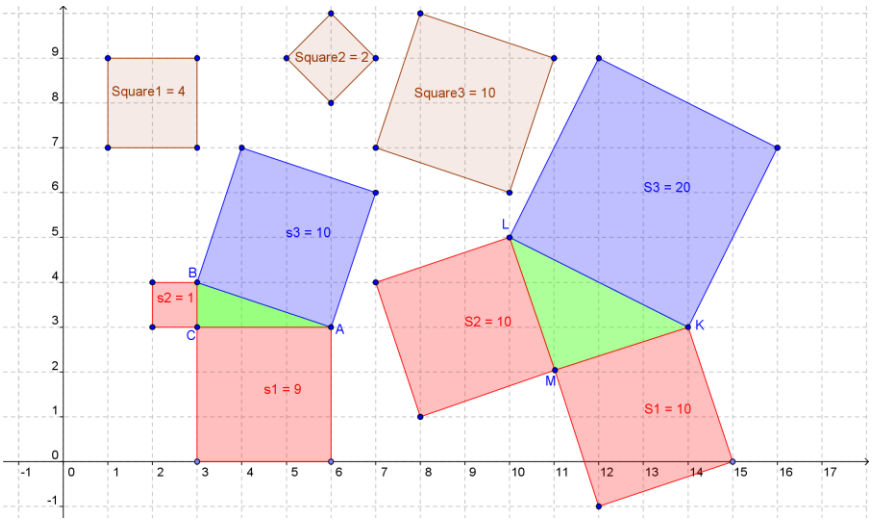

Figure 1

Some students´ works in GeoGebra

We can present now some students´ works prepared for different topics from the new curriculum. The examples were prepared by students – future teachers at Faculty of Education of Catholic University in Ružomberok. The first example is for the topic "The set of the points in the plane". We see on the figure 1 applet for the scathing the set of points with the property, that every point has the same distance k from the given line a. Parameter k is possible to change with slider.

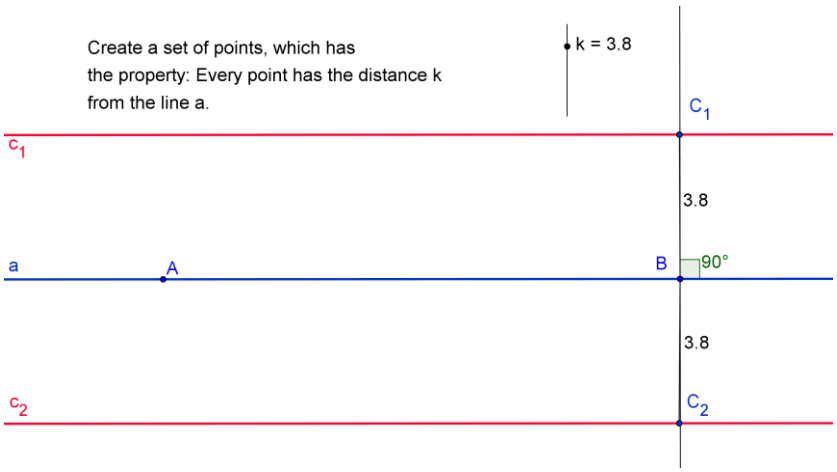

Figure 2

The second example explains how is possible to use the set of points, which was demonstrated before. The student uses it in the construction of triangle.

Example: Construct the triangle ABC, if you know the length of the side c, the high v_c of the side c and the median of the side t_c. Solve the example for the c = 6cm, v_c = 3cm, t_c = 4cm.

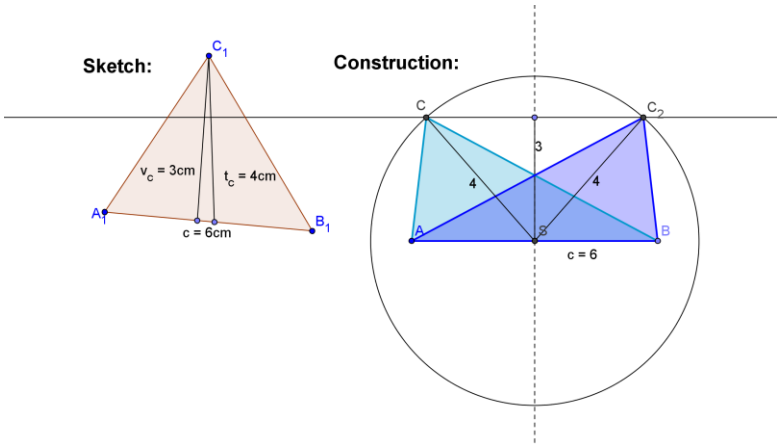

Figure 3

GeoGebra is suitable not only for Geometry, but also for calculus. The following figure represents definition of the function *y* = sin *x* via circle with radius 1.

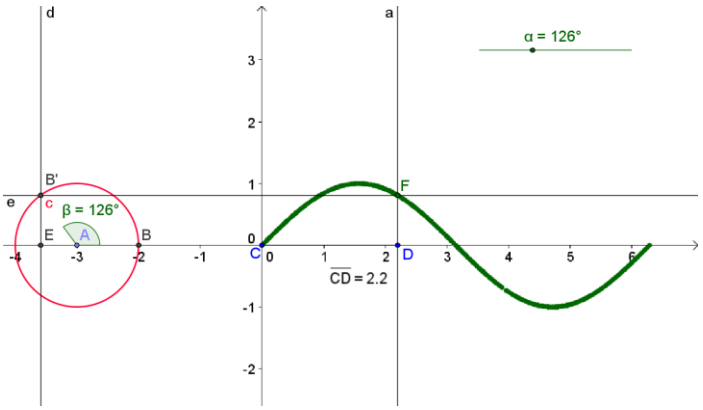

Figure 4

Lifelong learning for teachers in GeoGebra

The above presented examples shows how it is possible to motivate students in their learning process, in which student can be more a partner of teacher and the teacher´s role is more to be a moderator in the teaching and learning process. Nowadays it is important that students ´ work active during the lessons and they are not more only a passive receivers of information. That was more typical in the transmissional teaching, in which a student has no opportunity to create his own knowledge.

For this reason GeoGebra Institute can help teachers in this modernisation process. We can concrete in Slovakia using the new rules for the lifelong learning of teachers, which is based

on the credit system. The Institute in cooperation with universities and methodical centrums can prepare accredited courses for teachers. By this way it is possible to create a local partner school network, because every university in Slovakia works also in some regional level.

Conclusion

The GeoGebra research community has already international character which brings the opportunity to exchange the experiences in the field of motivation of pupils and students in Mathematics education. Several international projects are already realized in this field. The Faculty of Education of Catholic University in Ružomberok is a partner in the network CEEPUS HU 28 Active Methods of Teaching and Learnig of Mathematics and Informatics coordinated by University of Miskolc (see Körtesi (2009)). Our faculty has interest to participate also in other research projects which support motivational tools in Mathematics education in the classrooms and lifelong learning of the teachers. In the FP7 programme is defined specially subprogram for the Science Education. GeoGebra is useful also for teachers of some natural sciences, for this reason it is interesting to make research in the interdisciplinary dialogue between Mathematics education and education of natural sciences (see English version of the webpage http://konod.ku.sk).

Acknowledgements

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