Some Ideas for Applying the Synergetic Approach in Training Future Teachers of Mathematics

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Paper received 24.11.18; Revised 27.11.18; Accepted for publication 29.11.18.

https://doi.org/10.31174/SEND-HS2018-184VI30-12

Abstract. The article discusses some ideas for applying the synergetic approach in training future teachers of mathematics. It presents some technologies for incorporating "awakening education" in teaching mathematics to students from 5th to 8th grades.

Keywords: *synergetics, synergetic approach in education, teaching mathematics, awakening education in mathematics*

Acknowledgements: The article is partly sponsored through the Fund for Academic Research by Konstantin Preslavsky University of Shumen, Project № РД-08-164/08.02.2018

Introduction. The 45th session of the International Conference on Education in 1996 was entitled "Strengthening the role of teachers in a changing world". The discussions unambiguously showed that teachers are seen as key figures in the changes in the education system, which raised new expectations of teachers in general and, in particular, of teachers of mathematics. At the beginning of the 21st century the main goal of mathematics teachers is not only to form mathematical literacy but also to stimulate the formation of useful learning and innovation skills. These include creative thinking skills, critical thinking and problem-solving skills, communication and collaboration skills. The formation of these skills is possible in the process of education, which Kniazeva and Kurdyumov called 'awakening education' [5]. In the context of awakening education, education is seen as the awakening and stimulation of the inner forces, the potential of the pupil's personality, based on the co-operation of the subjects of education system, namely the educator and the educated.

Synergetics is defined as the new educational paradigm of the 21st century. Synergetics is a science that studies complex and nonlinear systems and their ability to self-organize and develop. Similarly, education is seen as a complex, nonlinear and open system, in which pedagogical objects, relationships and problems are analyzed and modeled, and solutions are sought from the standpoint of synergetics. Synergistic principles and approaches in education are discussed in detail in the joint work of the Bulgarian researchers M. Georgieva, D. Galabova, S. Grozdev, and E. Knyazheva from Russia, entitled "Synergic Approach in Higher Pedagogical Education". An article by Galabova [3, p.417] presents the model of awakening education in a synergistic aspect. According to this model, education is awakening if the teacher teaches students how to study / acquire methods of learning, not just knowledge /; when the teacher is a partner and collaborator, but also manages group and team work, plans and encourages self-education, stimulates thinking, promotes creativity.

Parameters of the study. The study investigates some modern approaches to using awakening education in teaching mathematics in the lower secondary education. It looks into the possibility of integrating traditional teaching of mathematics with information technologies, and creating conditions for the application of active training methods. The **aim** of the study is to create an appropriate educational environment in the higher school, stimulating university students to seek and discover approaches and means for activating the cognitive abilities of the pupils, aimed at realising the potential of each student. The study was carried out with students from Shumen University Bulgaria who studied Mathematics and Informatics in a Bachelor programme which also provides a teaching qualification, and students from the Master's programme "Pedagogy of Mathematics and Informatics" in the academic years 2016/2017 and 2018/2019.

The study had the following tasks:

- Research of relevant psychological, pedagogical and methodological literature on the studied subject by participating students;
- Investigation of interactive methods suitable for teaching mathematics;
- Understanding the essence of team work and its application in teaching mathematics to 5-8 grades;
- Development of appropriate learning resources to form a stimulating learning environment;
- Approbation of educational technologies.

During the two-year study period, 5 diploma theses were written, enigmatic materials were prepared for mathematics education, seven study projects were developed, and pedagogical experiments were carried out during students' internship practice.

These achievements showed that even in the age of high tech, we are still amazed by the power of nature and are capable of admiring its beauty. And when this beauty is explained in the language of mathematics, it always provokes interest in students.

This was the reason why we chose the theme "Curious facts about the golden ratio" studied as part of the unit "Proportions" in the 6th grade . Two teams were formed, and each team had a person responsible for monitoring team work and presenting the end product. The students were given time to prepare for the project. Results of the studies were systematized, summarized and presented through a computer presentation. The day for the submission of the projects was also determined. The themes students chose to work on were: "The Golden Ratio in Animals" and "The Numbers of Fibonacci in Animals." Due to word count limitations for this publication we only share a small part of the students' work from the first of the selected project themes.

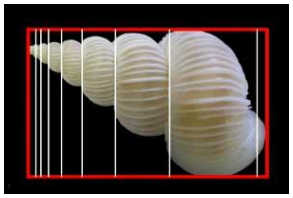

Fig. 1. Shell of the type Epitonium

The pupils had done research and discovered that in the world of animals the golden cratio section, known also as the golden proportion, which is marked by the Greek letter φ and

has a value of approximately 1,618, is found in the Epitonium shell. Each of the curves of this shell is larger than the previous one with just 1.62, and the whole shell fits in the so-called golden rectangle (width / length = 1 / 1.62)

They have also identified other animanls, in which the idicated parts have the same coefficient of proportionality 1,61(Fig. 2a, 2b,2c).

The work on this project provoked the students' creative thinking, put them in the role of researchers, helped them to develop their skills for teamwork, to enrich their knowledge, to solve problems with practical application of mathematics and to provoke interest and willingness to work. The research approach proved to be challenging for students and motivated them to look for the links between facts and regularities in nature.

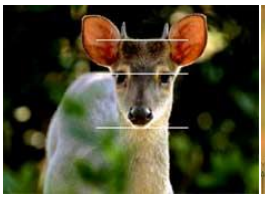

Fig. 2a

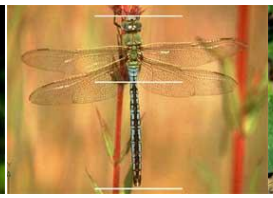

Fig.2б

Fig. 2в

Out of the 35 students surveyed, 78% said they liked working on projects, and 55% of them believed that it was a good chance for them to get a high grade. Most students pointed out that team work is an interesting way of learning and consolidating knowledge in mathematics, and some said that it was an opportunity to express themselves in the presentation of the project. A small number of students said that they did not want to spend time on projects, while others had not managed to decide on and understand their responsibilities in the team.

There are a lot of different opportunities to create interest and maintain a positive emotional attitude among students in math classes. One of these options turned out to be teamwork.

In the study entitled "Teamwork and Mathematics Education", some prerequisites for organizing successful work in teams in teaching mathematics were formulated. Here are some of the important lessons learned:

- Teamwork is a form of helping students' to achieve the educational purpose of the learning process;
- Teamwork helps to demonstrate students' different abilities;
- Teamwork breaks the routine of the traditional teacher-fronted class;
- Teamwork can and should be used in teaching mathematics mathematics both in and out of the classroom.

In order to achieve some of the research goals, one of the university students worked on the topic "Formation of Aesthetic Culture in Students through Mathematics Education". In her work she explained the essence of the term "aesthetics" and how it affects the learning process in teaching mathematics. The interrelation between art and mathematics was presented by listing historical facts about great mathematicians who were impressed by the beauty of nature, and great artists who were captivated by the beauty of mathematics. The preconditions for the successful integration of art in teaching mathematics were analyzed, and some possibilities for forming aesthetic culture were explored. She used different tasks which harmoniously combined art from antiquity to modern times, which contributed to raising learners' interest in the subject. Here is an example from her work:

Mosaics testify to the beauty of mathematics around us. One of the most common themes in the work of the Dutch artist Moritz Escher, covering surfaces of recurring shapes in the plain, attracts many admirers from mathematical circles.

Here is a composition of identical shapes in several variants (Fig. 3a, b, c), inspired by the paintings of M. Escher.

The difference between the examples given is the number of colored figures. In your notebooks please write:

1) the ratio between coloured and blank figures as a fraction;

2) Separate the proper from the improper fractions.

In the study of the types of equivalences in the 8th grade, other pictures by Escher can also be used, like in the following task: *Define what kind of equivalence in the plane Escher used in his paintings "Birds" and "Lizards" (Fig. 4a ,b).*

Conclusion. As a result of the study we found out that the future mathematics teachers were able to:

- Plan, organize and manage teamwork with students in working on projects;
- Create learning resources in which they successfully integrate mathematics and art;
- Teach mathematics in a way which provokes interest, willingness to work and, as a result, "awakens" and reveals more fully the potential of learners.

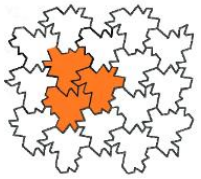

Fig. 3 a

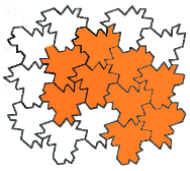

Fig. 3 b

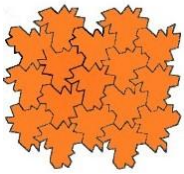

Fig. 3 c

Fig.4a

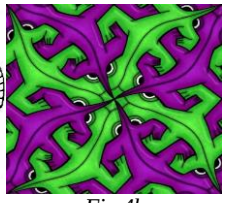

Fig.4b

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