

## CREATIVITY IN TEACHING MATHEMATICS

Teuta ILJAZI<sup>1</sup>

*Faculty of Pedagogy, University of Tetova*  
*\*Corresponding Author: e-mail: [teuta.iljazi@unite.edu.mk](mailto:teuta.iljazi@unite.edu.mk)*

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### Abstract

Creativity, attitudes, and conceptions of teachers regarding creativity in teaching mathematics have been examined in this study. The instrument used is a questionnaire consisting of three groups of questions. The first group of questions includes questions to gather general information about the teachers, while the second and third groups of questions include questions to gather data about teachers' attitudes and conceptions of creativity in teaching mathematics. The questionnaire was completed by 115 class and Maths teachers. After data analysis, the findings indicate that the majority of teachers have knowledge about creativity and believe that teachers are responsible for developing students' creativity. From the proven hypotheses of this paper, we can conclude that if the teachers know creativity, then they will teach the students to be creative, which they will further develop creativity, as a requirement of the 21st century.

**Keywords:** creativity, characteristics of creativity, creativity in teaching Mathematics

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### Introduction

Creativity occurs whenever people solve problems that they have not previously learned about or practiced solutions. Creativity has been defined in different ways. Some of the definitions focus on the process and some on the product (Haylock, 1987). Creativity during primary schooling with the different ways of manifestation has paid the greatest attention to creative writing and art. Now that we have a renewed recognition of the value of children's writing and art, it has been discovered that children can be creative in several other ways which are also important. Educators of the past viewed school-age children as incapable of creative and scientific thinking. (Torrance, 1977). Creativity is the production of something new or original. Creativity is sometimes defined as the contribution of original ideas, a different point of view, or a new way of looking at problems. Creativity is also defined as a successful step into the unknown by going off the beaten path, stepping outside the pattern, being open to experiences, and letting one thing lead to another or creativity is simply the recombination of ideas and noticing new relationships between ideas. Concepts such as curiosity, imagination, discovery, and innovation are concepts that describe creativity (Torrance, 1977). The last twenty or so years have seen a global revolution that in many countries has moved creativity from the fringes of education or the arts to be the core aspect of education. Science is often thought of as non-creative but rather as a body of certain and immutable knowledge. This narrow view fails to recognize the tentative nature of scientific theories and creative scientific discoveries, which expand our understanding of the Universe, changing the way we think and the way we see the world. (Wilson, 2009). According to Kamplis and Berki (2014), "Creative thinking is defined as thinking that enables students to apply their imagination to generate ideas, questions, and hypotheses by experimenting with alternatives and to evaluate their own and their peers' final ideas, products, and processes". Based on this, new ideas, questions that lead to new possibilities and solutions, validation of

hypotheses, and the introduction of a new product are defined as creativity. The mind that thinks differently, responds differently and finds new ways to reach a goal creates and generates. This happens in science, in art, wherever we have a product or divergent thinking.

Historically science has been innovative by involving discovery and critical thinking with creative and risk-taking scientists. Leonardo Da Vinci is considered one of the greatest artists and scientists for his works and ideas. He has created many important works and his ideas have influenced technological developments as well as the understanding of human anatomy. Many scientists have enhanced their understanding of the world through their discoveries. Such are Archimedes, Newton, M. Kiri, etc. Therefore, not only art but also science is creative. Science in education has an impact on the perception and understanding of science itself. Differences in understanding are influenced by social views, worldviews, and scientific education. The sciences that are taught during the schooling of children in different countries are based on different elements, for example in Japan or North Macedonia where mathematics, physics, and chemistry are taught as secondary sciences, they are based on knowledge and focus on the curriculum. While some countries focus on the development of student's skills and are student-centered. Creativity is present in many educational policy documents. Among these are Canada where creative thinking is emphasized as one of the most essential lessons, and Kentucky (USA), where one of the learning goals is to enable students to use creative thinking skills to develop or invent new ideas or products. In Korea, the National Curriculum defines an educated person as a "healthy, independent, creative and moral person". In Sweden, the Government plan for the development of preschool, school, and adult education (1997) emphasizes that education should provide conditions for the development of creative skills. In France, the expectation is that education in the lower grades provides children with a sense of creativity. In Germany, the emphasis of primary education is on the development of "children's creative abilities". In the Netherlands, one of the principles on which primary education is based is creative development (Shaheen, 2010). In our case, although creativity is mentioned in documents, it is to ask how much what is written is applied in practice. The causes can be assumed to be various, such as lack of conditions in schools, lack of teachers' motivation, lack of cooperation between institutions, lack of training and workshops for teachers, paper-only educational policies, etc. For the student to be creative, s/he needs a creative learning environment with conditions to encourage creative thinking; however, this is not enough without a teacher who will manage that environment and the students themselves. Investments must be in many directions, in visionary educational experts who lead and create educational policies that are updated for the sole purpose - quality education and teaching, versatile and well-prepared teachers, in school environments that are attractive for students so that they can become curious thinkers, and creators. Creativity starts from an early age; therefore, encouraging and develop children's creativity is everyone's duty, starting from the parent, educator, teacher, professor, environment, society, and the whole state. All together can produce creative people who will establish creative societies.

### **Research methodology and results**

This research was carried out during the year 2023 and its purpose is to collect data regarding creativity in the teaching of mathematics, namely the attitudes and understandings of classroom teachers and teachers of mathematics in the higher grades of primary education. The questionnaire is an adaptation of the questionnaire of A. Aljughaiman & E. Mourer-Reynolds (2005). The collected data were processed with the help of SPSS. A total of 115 teachers completed the questionnaire, of which 77.4% were females. One of the questions of

this questionnaire was the age of the teachers. The following table (Tab.1) presents the groups of teachers formed according to their age.

**Table 1.** Teachers' participation by age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 29	8	7.0	7.0	7.0
	30-39	34	29.6	29.6	36.5
	40-49	26	22.6	22.6	59.1
	50-59	29	25.2	25.2	84.3
	60-69	18	15.7	15.7	100.0
	Total	115	100.0	100.0	

From the table, it can be seen that teachers aged 30-39 are represented the most with 29.6%, while those aged 50-59 are represented with 25.2% and are in second place. The representation of other groups is smaller. The age group with less than 29 years is the least represented, with only 7%.

According to the law on primary education, the person who has completed the pedagogic faculty of pre-school management, classroom management, or the relevant faculty for the higher cycle of primary school, namely subject teaching, has the right to exercise the teaching profession. The questionnaire was completed by 28.7% of subject teachers, 69.6% of classroom teachers, and only 1.7% of preschool teachers.

**Table 2.** Teachers' participation according to classes where they teach

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I	7	6.1	6.1	6.1
	II	14	12.2	12.2	18.3
	III	13	11.3	11.3	29.6
	IV	24	20.9	20.9	50.4
	V	21	18.3	18.3	68.7
	VI	9	7.8	7.8	76.5
	VII	6	5.2	5.2	81.7
	VIII	8	7.0	7.0	88.7
	IX	13	11.3	11.3	100.0
	Total	115	100.0	100.0	

Table 2 shows the distribution of teachers according to the classes where they teach. Of the total number of teachers, 20.9% of teachers work with the fourth grade, 18.3% of the teachers work with the fifth grade, and 12.2% work with the second grade, while the others are less represented. Creativity as a skill that must be developed from an early age requires creativity, support, and commitment from teachers, the family, and the

whole society. The 21st century is a race of creativity, innovation, and the application of infinite information. With this in mind, the questionnaire contains questions about teachers' attitudes regarding creativity.

**Table 3.** Teachers' attitudes toward creativity

	Strongly disagree	Disagree	Partially agree	Agree	Strongly agree
Creativity can be taught	1.7%	8.7%	27%	28.7%	33.9%
Student creativity can be developed in the classroom	-	4.3%	26.1%	32.2%	37.4%
Teachers should have knowledge about creativity	9%	-	7.8%	27%	64.3%
Creativity is essential for enhancing student academic learning in school	-	1.7%	26.1%	32.2%	40%
The classroom teacher is responsible for helping students develop creatively	0.9%	0.9%	16.5%	29.6%	52.2%
The school where I teach places emphasis on fostering student creativity	1.7%	2.6%	27%	34.8%	33.9%
I employ many methods in my classroom to foster creativity	1.7%	-	11.3%	40%	47%

Table 3 presents the teachers' attitudes regarding creativity. Teachers' answers have been scaled according to the Likert scale starting from 1 for completely disagree to 5 for completely agree. From the presented table, it can be seen that the teachers think that creativity in students can be learned and developed in the classroom. This attitude can be supplemented with the attitude that the classroom as an environment for creativity helps the creativity of the student, also the enthusiastic and visionary teacher produces creative students. These two conditions without each other cannot realize the goal of 21st-century society – producing students with creative skills. Table 3 also presents the attitude of the majority of teachers that the teacher should know creativity. Also, 52.2% of teachers think that the teacher in the classroom is responsible for helping the development of creativity in students. From this, teachers know the importance of creativity and its role in the further development of the student. Classroom teachers use different methods to encourage students' creativity because this is the only way to be equal in the global competition of the 21st century. From the total number of teachers, 47% and 40% of teachers completely agree and agree that they use different methods in teaching mathematics to promote creativity. This is evident in the teaching of mathematics in North Macedonia since the approaches to the development of creativity, critical thinking, problem-solving tasks from everyday life are a requirement of educational programs since primary education.

**Table 4.** Teachers' conceptions toward creativity

	Teachers' conceptions of creativity (n=115) (2023)	Teachers' conceptions of creativity (n=36) A. Aljughaiman & E. Mowrer-Reynolds (2005)
<b>Creativity involves:</b>	<b>% Agreement</b>	<b>%Agreement</b>
Original ideas	93%	88.23%
Aesthetic product	71.3%	35.29%

Intelligence	94.8%	35.29%
Linguistic product	80%	29.41%
Imagination	100%	26.47%
Self-expression	89.6%	26.47%
Problem solving	83.5%	20.59%
Enjoyment	85.2%	20.59%
Divergent thinking	66.1%	14.71%
Inventiveness	79.1%	8.82%
Creative writing	88.7%	8.82%

Table 4 presents the results that enable the comparison of the results obtained during this research carried out in 2023 with the obtained results of the research of A. Aljughaiman & E. Mowrer-Reynolds carried out in 2005. From the data presented in this table, it can be seen that there is a big difference regarding the attitudes of teachers (2023) and the teachers included in the paper of A. Aljughaiman & E. Mowrer-Reynolds (2005). The answer lies in the changes in the educational system, the rapid development of technology, the adaptation of teachers to the demands of the 21<sup>st</sup> century, the demands of society and global education. From this table we have the data that show that teachers are able to identify the characteristics of creativity in students during their teaching of mathematics. School mathematics promotes thinking, critical and creative thinking in students if it follows the steps of development in the science of mathematics, technology, society and its requirements.

**Table 5.** Pearson correlation coefficients

		Creativity can be taught	Creativity can be developed	Teachers should have knowledge about creativity
Creativity can be taught	Pearson Correlation	1	.616 **	.470 **
	Sig. (2-tailed)		.000	.000
	N	115	115	115

Table 5 presents the values of the Pearson coefficient, which prove the validation of the alternative hypotheses of this paper. The hypotheses of this paper are:

- H1a: 'Creativity can be learned' is dependent on 'creativity can be developed' (0.616, 0.000).
- H2a: 'Creativity can be learned' is dependent on teachers' knowledge of creativity (0.470, 0.000).

From the proven hypotheses, we can conclude that if the teachers know creativity, then they will teach the students to be creative, which they will further develop creativity, as a requirement of the 21st century.

Creativity as a skill of the 21st century must be learned and developed in students, but it must also be followed and evaluated continuously to achieve the best possible results (Iljazi. T, 2013).

## Conclusions and recommendations

After processing the results of this research, it was concluded that teachers have sufficient knowledge about creativity and that they apply teaching methods to encourage creativity in students while teaching mathematics. Also, teachers think that schools also support the development of creativity in students. The teachers think that the students' creativity can be learned and developed and that the teacher is responsible for this; that is why they also use different methods in their teaching.

Based on the obtained results, the way technology is developed, the amount of information we have access to, the globalization of society, education, the market, and competitions that are present in every sphere of people's everyday living across the globe, creativity must be developed continuously during teaching mathematics. Also, the school should provide an environment for encouraging and developing creativity in students, an innovative environment as well as creative and enthusiastic teachers. Competent bodies should constantly organize training and workshops for teachers. Curricula should be updated and adapted to the requirements of the time. Textbooks, especially mathematics textbooks, should be compiled to encourage creative teaching and creative learning.

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