OPINIONS OF TEACHERS ON THE MANIFESTATIONS OF STUDENTS' CREATIVITY IN THE STUDY OF NATURAL SCIENCES

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Abstract

Creativity is a complex concept, defined in the literature of the field as the ability to generate original ideas, methods or objects or to reuse existing ones in a new way. Research on creativity has focused both on the characteristics of creative personalities (thinking, attitude, behavior) and on creative processes and products. They also aimed to identify a typology of creativity and characteristics of creative personalities.

Creative teaching is an art for which there are no recipes for success or routines. However, the teacher's pro-creativity strategy and the use of teaching strategies with a recognized impact to develop creativity can stimulate students' creative thinking and attitudes and form behaviors designed to contribute to the realization of products considered to be creative.

The study of natural sciences, through the methodology specific to the process of scientific knowledge facilitates the development in students of those reasonings valuable for creative thinking: convergent, divergent, associative and synthetic reasoning. Also, the variety of manifestations of science in our lives stimulates emotional creativity.

This study presents the results of a survey that aimed to explore teachers' opinions on student creativity and the manifestations of students' creativity in the study of natural sciences. 112 teachers participated in the research and participation in the survey was voluntary, the data being collected online. The majority of respondents said that they develop the creativity of their students by valuing creativity, by using modern teaching methods, by permanently adapting the methodology, by offering the possibility to make choices and having options, by offering models of creative behavior or by ensuring a diversity of creative products. All respondents agreed that the students' creativity can be easily developed in full subjects of the natural sciences.

Keywords: *creative teaching, creative personality, elementary teachers*

1. INTRODUCTION

Creation is the most evolved form of manifestation of creativity and can be approached interdisciplinary, because it involves a multitude of facets, from the person involved in the creative act through an activity to which he dedicates, to the result of his actions that can be a truly new and recognized product, an innovation or invention (Enăchescu, 2015).

Creativity is defined in the literature of the field as the ability to generate new ideas, theories, methods and techniques, works or artifacts, original and useful or valuable, obtained through innovation, adaptation, use or reuse in a new way (Carson, 2010 cited by Lambert, 2017). Isbell & Yoshizawa (2016, citing Carson, 2010 and Isenberg & Durham, 2015) define creativity manifested about an idea or product, in terms of uniqueness, originality, utility and adaptability. Dietrich (2019) talks about creativity in terms of deliberate mode, a spontaneous mode, and a flow mode. Galbraith (2017, Robinson citing) links creativity to tangible outcomes and Gilhooly (2022) to "surprise".

Research on creativity has also focused on the characteristics of creative personalities (thinking, attitude, behavior) and creative processes and products, aspects that are easy to operationalize (Runco, 2022). Most researchers propose a typology of creative people (Filteau, 2009).

Regarding the relationship of creativity with teaching, we can talk about the pro-creativity attitude of the teacher manifested either in designing and carrying out learning activities (creative teaching) or in

order to develop students' creativity (teaching for creativity). Creative teaching is an art for which there are no recipes for success or routines (Zulkifli, Tamuri & Azman, 2022). It is a proof of the didactic mastery of the teacher who uses in a creative manner the training and evaluation strategies to achieve the proposed objectives. Teaching for creativity involves designing the training process to provide students with opportunities to manifest their creativity (Starko, 2010; Gregoire, 2017). For this purpose, the teacher selects and uses teaching strategies with a recognised impact on stimulating students' thinking and creative abilities (Davies & McGregor, 2017). The creative teacher must get out of the daily routine, optimize his teaching practices through creativity and encourage his students to develop their creativity at each stage of the instructive-educational process, focusing on generating and expressing ideas in a non-evaluative setting.

Science is a major field of human mental and practical activities. Together with technology, it takes on an expanding role in our lives (Harlene & Qualter, 2018). The study of natural sciences, through its specific methodology, facilitates the development in students of reasoning that, in large part, is also valuable for creative thinking: convergent, divergent, analog, associative and synthetic reasoning. When children investigate a scientific phenomenon, they learn systematic approaches to problem-solving through investigation and evidence-based reasoning. They also develop research skills transferable to life: formulating questions and hypotheses, planning, collecting and interpreting evidence, analysis, synthesis, evaluation. It should also be emphasized that the variety of manifestations of science in our lives stimulates emotional creativity, and facing uncertainty and change increases their tolerance for ambiguity (Harlen, 2008).

According to Freinet pedagogy, the basis of creativity is freedom of manifestation, freedom of thought and freedom of expression of knowledge, thoughts and facts. In this respect, activities that require spontaneity and contribute to the development of independence in thinking and acting are recommended (Cosmovici & Iacob, 1999). Providing creative freedom to students means providing them with basic, solid knowledge that they can use in a creative and innovative manner.

The purpose of this study is to identify teachers' opinions on the development of creativity in teaching practice, in general and in the study of natural sciences, in particular:

a) respondents' opinions on the development/stimulation of pupils' creativity;

b) respondents' opinions on the characteristics of the creative learner;

c) respondents' opinions on the barriers encountered by students in developing creativity;

d) teachers' opinions on the relationship of creativity with the study of natural sciences.

2. METHODS

Questionnaire survey method was used. The questionnaire was applied online, participation being voluntary. Responses were collected using a 5-step Likert scale from 1 to 5, where 1 means strongly disagree and 5 strongly agree. The survey was conducted over a period of two months in the second semester of the academic year 2022-2023.

Respondents:

Subjects. The research was attended by 112 subjects from all over the country, from educational institutions in rural and urban areas. The vast majority of subjects involved in research come from Babeș-Bolyai University. 88.5% of respondents are women, 41.6% of respondents are licensed and 47.8% respondents hold a master's degree, the rest of the participants being doctoral students.61.9% of respondents teach at primary level, 17.7% at preschool level and 8% have the specialty teachers, 2.7% educators and 9.7% in secondary and high school education. Regarding the experience at the department, 11.5% respondents have an experience at the department under 5 years; 9.7% between 5-9 years; 14.2% between 10-14 years; 16.8% between 15-19 years and 20.4% between 20-24 years, 12.4% between 25-29 years and 9.7% is 30 years and 5.3% answered that they fall into another age category. 6.2% have

not yet obtained completion in education, 13.3% have completed in education, 12.4% have grade II and 68.1% have grade I.

3. RESULTS

3.1. Respondents' views on the development of creativity in general and teaching practice in particular

The answers received appreciate the teacher's role (Q14: m=4.56; SD=.655 and Q17: m=4.44; SD=.720) and interactive methods (Q16: m=4.42; SD=.743) in developing students' creativity. Respondents appreciate that students' creativity can be developed through natural science lessons (Q12: m=4.21; SD=.821) but they do not play an essential role.

Table 1. Statistical indicators (mean and standard deviation) relative to scores recorded on *general questions about acquiring creativity,* Q11->Q17, depending on teaching experience

Experience at the department	Respondents	Q11. Creativity can be learned	Q12 Students' creativity can be developed in natural	Q13. Natural sciences are essential disciplines for the	Q14. A teacher should help his students develop their	Q15. The school where I teach focuses on	Q16. I use several interactive methods in my	Q17. I am an example of a creative person for my
	%/(f)	m/SD	m/SD	m/SD	m/SD	m/SD	m/SD	m/SD
Under 5 years	11.61% (13)	3.77 1.301	4.00 .913	3.62 .961	4.69 .480	3.77 1.013	4.46 .660	4.54 .660
5-9 nor	9.82% (11)	3.36 1.206	3.82 1.250	4.27 1.272	4.45 .820	4.27 1.009	4.55 .688	4.45 .934
10-14 nor	13.39% (15)	4.13 .640	4.53 .640	3.87 .516	4.67 .724	3.87 1.187	4.33 .724	4.47 .737
15-19 nor	16.99% (19)	4.00 .816	4.11 .737	3.79 .976	4.37 .684	3.95 .911	4.21 .976	4.32 .582
20-24 nor	20.54% (23)	4.26 1.096	4.39 .722	4.04 .928	4.74 .449	4.22 .951	4.61 .656	4.48 .846
25-29 nor	12.50% (14)	4.07 .917	4.50 .760	3.79 .893	4.57 .646	4.29 .726	4.64 .633	4.64 .497
30-34 nor	9.82% (11)	4.00 1.000	4.18 .751	3.82 1.079	4.55 .688	4.45 .522	4.18 .603	4.37 .674
Other value	5.36% (6)	3.33 1.211	3.67 .516	3.50 1.049	4.17 .983	4.17 .983	4.17 .983	4.17 .983
Total	112	3.96 1.026	4.21 .821	3.87 .944	4.56 .655	4.11 .933	4.42 .743	4.44 .720

To analyze how experience at the department influences the average score recorded on *general questions about acquiring creativity* , the Monofactorial Anova was used. The highest average scores on *general questions about acquiring creativity* were registered in the category of respondents with a seniority of 20-24 years, followed by the category of seniority 25-29 years. The lowest average scores occur for those who have more than 34 years of service in education relative to all questions asked. The seniority categories 15-19 years and 5-9 years respectively rank next two in terms of relatively low average score expressed in relation to *general questions about acquiring creativity.* The same method shows that there are no statistically significant differences between the average scores obtained on *general questions about creativity* acquisition according to teacher experience.

Table 2. Statistical indicators (mean and standard deviation) relative to *general questions about acquiring creativity* depending on the respondents**' studies factor**.

Respondents' studies	Respondents	Q11. Creativity can be learned	Q12 Students' creativity can be developed in natural	Q13. Natural sciences are essential disciplines for the	Q14. A teacher should help his students develop their	Q15. The school where I teach focuses on stimulating	Q16. I use several interactive methods in my class/group to	Q17. I am an example of a creative person for my
	%/N	m/SD	m/SD	m/SD	m/SD	m/SD	m/SD	m/SD
Secondary school	7.1%	3.88	4.13	3.88	4.50	4.13	4.00	4.13
	8	.641	.835	.641	.765	.641	.535	.835
License	41.6%	4.02	4.13	3.79	4.51	4.11	4.45	4.49
	47	1.093	.824	.999	.655	.983	.775	.718
Master	47.8%	3.94	4.32	3.91	4.62	4.09	4.47	4.45
	53	1.008	.803	.946	.657	.986	.723	.637
PhD	16.99%	3.50	4.00	4.25	4.50	4.25	4.25	4.25
	19	1.291	1.155	.957	.577	.957	.957	1.500
Total	112	3.96	4.21	3.87	4.56	4.11	4.42	4.44
		1.026	.821	.944	.655	.953	.743	.720

The recorded answers emphasize that Natural Sciences is considered an essential discipline for the development of students' creativity by doctoral students (m=4.32; SD.803). All categories of respondents appreciate that the teacher has an important role in the development of students' creativity (m≥4.50).

The highest average scores on general questions about acquiring creativity were registered in the category of master's degree respondents, followed by the doctoral and bachelor's categories. The lowest average scores occur for those who graduated from high school.

Table 3. Statistical indicators (mean and standard deviation) relative to scores recorded on general questions about what creativity entails, Q18->Q29

	N	Mean	Std. Deviation
Q18. Creativity involves original ideas	112	4.49	.735
Q19. Creativity involves aesthetic products	112	3.90	1.022
Q20. Creativity involves intelligence	112	4.21	.922
Q21. Creativity involves language products	112	3.88	1.063
Q22. Creativity involves imagination	112	4.66	.594
Q23. Creativity involves expression through various means	112	4.42	.743
Q24. Creativity involves problem solving	112	4.23	.920
Q25. Creativity implies joy	112	4.37	.870
Q26. Creativity involves divergent thinking	112	4.46	.734
Q27. Creativity involves inventiveness	112	4.65	.581
Q28. Creativity involves creative writing	112	4.21	1.032
Q29. Creativity involves other aspects	112	4.37	.921
Valid N (listwise)	112		

Cronbach's Alpha coefficient for the item category describing the components of creativity is 0.868.

The highest average scores are recorded by items that relate creativity to imagination (m=4.66; SD=.594) and inventiveness (m=4.65; SD=.581) and the lowest average score is recorded for the item "Creativity involves language products" (m=3.88; SD=1.063).

Items referring to common features of creativity and scientific knowledge score high average scores: divergent thinking (m=4.46; SD=.734), original ideas (m=4.49; SD=.735): The exception is problem solving for which the average score is lower (m=4.23; SD=.920).

The component "Creativity involves imagination" recorded the highest percentage of agreement from respondents, 72.3%.

3.2. Respondents' opinions on the characteristics of the creative learner

Table 4. Statistical indicators (average and standard deviation) relative to the scores recorded on general questions about the characteristics of the creative student.

	N	Mean	Std. Deviation
Q30. The creative learner thinks creatively	112	4.57	.694
Q31. The creative learner has a rich imagination	112	4.60	.592
Q32. The creative learner takes risks	112	4.11	.904
Q33. The creative student has an artistic nature	112	4.29	.897
Q34. The creative learner has a rich vocabulary	112	4.20	.948
Q35. The creative learner is enthusiastic in the learning process	112	4.29	.812

Q36. The creative learner is smart	112	4.25	.915
Q37. The creative learner has a developed sense of humor	112	3.81	1.212
Q38. The creative learner is curious	112	4.45	.757
Q39. The creative learner is a deep thinker	112	4.09	.916
Q40. The creative learner is open-minded	112	4.46	.721
Q41. The creative learner is sensitive	112	4.11	1.017
Q42. The creative learner is independent	112	4.12	.956
Q43. The creative learner is flexible in thinking	112	4.30	.826
Q44. The creative learner is intuitive	112	4.32	.738
Q45. The creative learner has other traits	112	3.99	1.127
Valid N (listwise)	112		

The analysis of the data in Table 4 allows to identify a profile of the creative learner. Thus he has a rich imagination (m=4.60; SD=.592), creative thinking (m=4.57; SD-.694), open mind (m=4.46; SD=.721), curiosity (m=4.45; SD=.757), intuition (m=4.32; SD=.738) and flexible thinking (m=4.30; SD=.826). Most of these traits are valuable for the study of natural sciences. It should be noted, however, that there are two important features for the study of science: risk-taking (m=4.11; SD=.904) and deep thinking (m=4.09; SD=.916) that do not score high average as characteristics of creativity.

The Cronbach's Alpha coefficient for the category of items that present the traits of the creative student is 0.915. Relative to the traits of the creative learner monitored in this study, total agreement is most commonly expressed. The highest percentage for total agreement is registered in the question "The student thinks creatively."

As for the respondents' students, they record average scores between [4.13-4.31] on the capacities to transfer and deepen knowledge, to concentrate, to identify new solutions or to adapt them, etc. (Table 4).

Table 5. Statistical indicators (mean and standard deviation) relative to scores recorded relative to creative student ability, Q46->Q51

	N	Mean	Std. Deviation
Q46. My students have the ability to transfer the knowledge they have gained in one context to another, for problem solving	112	4.20	.826
Q47. My students have the ability to understand that learning is a process in which knowledge acquisition involves the transition from a lower level of complexity to a higher one	112	4.13	.895
Q48. My students have the ability to concentrate for a long time when needed to achieve a result	112	4.18	.893
Q49. My students have the ability to identify new solutions	112	4.29	.907
Q50. My students have the ability to creatively adapt known solutions	112	4.31	.860
Q51. My students have the ability to optimize the products obtained in a creative manner	112	4.22	.898
Valid N (listwise)	112		

The Cronbach's Alpha coefficient for the item category describing the student's creative ability is 0.919.

The highest percentage of respondents, 51.8%, fully agree with the option "My students have the ability to identify new solutions". At the same time, teachers strongly agree that in Natural Sciences class their students have the ability to creatively adapt known solutions (m=4.31).

3.3 Respondents' views on barriers encountered by students in developing creativity

Table 6. Statistical indicators (average and standard deviation) relative to the indicated barriers to the manifestation of creativity, both from the perspective of students and teachers. Q52->Q53

	N	Mean	Std. Deviation
Q52. Barriers encountered by students in capitalizing on creativity	112	5.15	2.791
Q53. Barriers encountered by teachers in terms of creativity development	112	3.97	2.086
Valid N (listwise)	112		

According to respondents, students have more difficulties in harnessing their creativity than teachers who aim to develop students' creativity. Explanations are provided by Table 7.

The highest percentage of respondents, 23.2% consider *the lack of resources* and rigidity of teachers (17%) a barrier encountered by students to capitalizing on creativity. The lowest percentage of respondents, 2.7%, consider *the Internet and limited vocabulary* a barrier encountered by students to harnessing creativity (Table 7).

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Table 7. Types of identified barriers to the manifestation of creativity.

Barriers encountered by students in capitalizing on the manifestation of creativity		Frequency	Percent
Valid	School environment	15	13.4
	Fear of failure	12	10.7
	Lack of motivation	15	13.4
	Internet	3	2.7
	Time	14	12.5
	Limited vocabulary	3	2.7
	Lack of resources	26	23.2
	Freedom of expression	5	4.5
	Rigid teachers	19	17.0
	Total	112	100.0

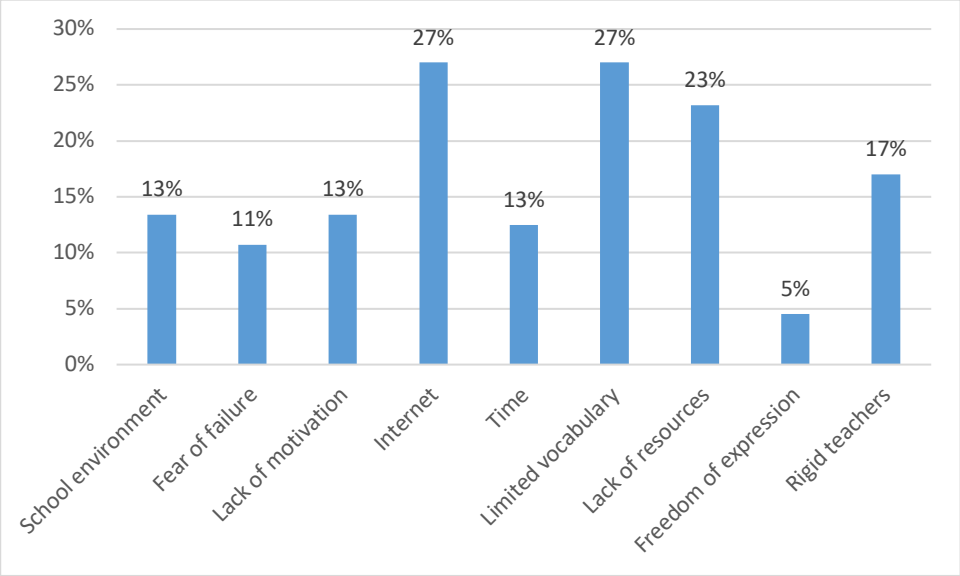

Figure 1. Types of identified barriers to the manifestation of creativity.

4. DISCUSSION

In natural science classes, students' creativity can play an essential role in developing their critical thinking, problem-solving, and understanding of phenomena in the world around them. Teachers' perspective on student creativity can be influenced by several factors:

1. Encouraging the free expression of ideas: Teachers can support students' creativity by encouraging the free expression of ideas, even if they seem unconventional or outside the usual patterns. During lessons, teachers can create a safe environment where students are encouraged to think beyond the information taught and ask questions.
2. Promoting unconventional approaches: Teachers can encourage students to approach scientific problems unconventionally and explore new and innovative solutions. This can be achieved by challenging students to find creative ways to test hypotheses or investigate natural phenomena.
3. Interdisciplinary approach: Teachers can foster an interdisciplinary approach to natural science teaching, combining elements from different disciplines and inviting students to make connections between different fields. It can stimulate creative thinking and the development of innovative perspectives on problems or phenomena.
4. Teamwork and collaboration: Teachers can promote teamwork and collaboration between students on practical projects or activities. This can provide opportunities for creativity to develop through the exchange of ideas and solutions between colleagues.
5. Valuing failure as part of the learning process: Teachers can support students' creativity by encouraging a positive attitude toward failure and learning from mistakes. It is important for students to feel comfortable experimenting and trying various approaches without fear of being judged negatively for their possible errors.
6. Use of technology and interactive resources: Teachers can use technology and interactive resources to stimulate student creativity. For example, they can use computer simulations, virtual experiments or other innovative technologies that allow students to explore and understand natural phenomena in an interactive and immersive way.
7. Encouraging questioning and investigation: Teachers can stimulate students' creativity by encouraging the formulation of personal questions and investigations. When students are encouraged to follow their curiosity and seek answers, they can discover new ideas and connections.

5. CONCLUSIONS

Our study explores teachers' opinions on creativity (development of creative abilities, creative personality/creative learner, manifestations of students' creativity in natural science classes). Most respondents (primary school teachers) appreciate that creativity involves imagination, involvement and that natural sciences are an important subject for the development of students' creativity.

Creative individuals have a rich imagination, which can be developed to students through the right teaching-learning strategies. Every teacher must be concerned with developing the creativity of his students, using the appropriate teaching methods and means in the classroom.

Teachers say that their students face multiple barriers to creativity, the fiercest of which is the lack of resources, the rigidity manifested by some teachers, the school environment and the lack of motivation that does not support creative manifestations.

In conclusion, students' creativity in natural sciences classes can be supported by creating an enabling environment in which free thinking, innovation, collaboration and interdisciplinary exploration are encouraged. Through these approaches, students can develop essential cognitive and critical skills and gain a deeper, more personal understanding of the world around them.

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