JMETP
Journal for the Mathematics Education and Teaching Practices, 5(2), 111-116, Dec 2024
e-ISSN: 2717-8587
dergipark.org.tr/jmetp

Young Wise Publishing
youngwisepub.com
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Math Teaching Practice

Multi-solution teaching activity for developing mathematical creativity of gifted students

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Article Info

Received: 7 November 2024
Accepted: 29 December 2024
Available online: 30 Dec 2024

Keywords:
Mathematical creativity
Gifted students
Math teaching practise

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Abstract

Mathematical creativity is a skill that comes to the fore especially in problem solving and is expected to develop in students. In this sense, it is important to provide opportunities for gifted students to develop their creativity and mathematical creativity skills in mathematics learning processes. The aim of this study is to realise an instructional activity that can be used in the development of mathematical creativity in gifted students and can offer them multiple perspectives. In this direction, the multi-solution task activity 'Dividing a Square into Four Equal Parts' developed by Hershkovitz et al. (2009) was used in the preparation and implementation processes of the teaching activity. The results obtained as a result of the activity showed that the students developed a high level mathematical perspective and proposed new types of solutions for the three questions asked in the activity. Moreover, as an important result, this teaching activity provided students with a different perspective in terms of mathematical flexibility, fluidity and originality. By analysing all the drawings of the students, it was concluded that they consciously performed the desired operation of each problem.

To cite this article

Kırmızıgül, H.G. (2024). Multi-solution teaching activity for developing mathematical creativity of gifted students. *Journal for the Mathematics Education and Teaching Practices, 5*(2), 111-116. DOI: https://doi.org/10.5281/zenodo.14599909

Introduction

Today, there are a number of basic skills that individuals should have and develop, increasing their importance day by day. One of these skills is creativity. Creativity, with its most general and accepted definition, is the ability to produce solutions to problems with innovative approaches, to produce useful, original products and a thinking skill that includes all these (Torrance, 1974). Creativity, which has many definitions in the field but focuses on two basic elements (appropriate, useful and original, new), is the ability to produce a new product (Sternberg et al., 2002). Creativity, which is emphasised and researched in many fields, is also researched in mathematics. In this sense, creativity in mathematics is defined as the ability to bring innovative solutions to problems by using existing knowledge, concepts and thinking strategies (Kim et al., 2016; Sriraman, 2009). At the same time, mathematical creativity is seen to be effective on mathematical thinking and closely linked to reasoning and association (Ervynck, 1991). Accordingly, mathematical creativity is considered as an important component in mathematics learning (Pitta-Pantazi et al., 2022). Krutetskii (1976), with the most widely accepted studies on giftedness in mathematics, argues that mathematical creativity is an important component of mathematical giftedness. mathematical creativity, combined with high mathematical performance, is one of the cornerstones of mathematical giftedness (Leikin, 2019).

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In line with the general framework pioneered by Torrance (1974), the four components of creativity, namely fluency, flexibility, novelty, and elaboration, were summarised by Leikin and colleagues (2009) and provide important information about gifted students in mathematics and mathematical creativity. This conceptual basis focuses on the components of flexibility, fluidity and originality in problem solving activities for gifted individuals in mathematics. Flexibility refers to the presence and number of different solutions, fluidity refers to the sum and presence of all solutions, and originality refers to the presence and number of non-ordinary representations. In addition, evaluation is provided with two components: effectiveness (number of correct solutions) and stability (time spent on the task). Similarly, Sheffield (2009) emphasised the importance of students' fluency in examining the causes of problems, their ability to use information flexibly, and their ability to solve problems with original approaches in mathematical creativity problems.

In the development of creativity in mathematics, it is generally advocated that open-ended problems with multiple solutions should be preferred and students should examine the solutions in terms of fluency, flexibility and originality components by focusing especially on the solution processes (Assmus & Fritzlar, 2022; Gruntowicz, 2020; Leikin, 2009). Students who are considered gifted in mathematics need different instructional designs than other students with typical development (Erdoğan & Gül, 2023). In this sense, it is important to provide mathematically gifted students with opportunities to develop their mathematical thinking and creativity skills in mathematics learning processes (NCTM, 2016). Bıçakçı and Baloğlu (2018) stated that research on creativity skills in gifted students has an important response in Turkey. From this point of view, the studies conducted and to be conducted for the development of creativity, especially mathematical creativity, in gifted students gain value and are considered important.

Purpose of Teaching Activity

The aim of this study is to implement an instructional activity that can be used to develop mathematical creativity in gifted students and that can offer them multiple perspectives. In this direction, the multi-solution task activity 'Dividing a Square into Four Equal Parts' developed by Hershkovitz et al. (2009) was used in the preparation and implementation processes of the teaching activity.

Structures of Math Teaching Practice

The teaching activity is related to polygons in the mathematics curriculum, especially in the geometry learning domain. The multi-solution task 'Dividing a Square into Four Equal Parts' developed by Hershkovitz et al. (2009) encourages originality in line with the diversity of solution categories and the high level of originality that can be seen in children's work. In this direction, sample drawing types in Hershkovitz et al.'s (2009) own study are given in Figure 1 below.

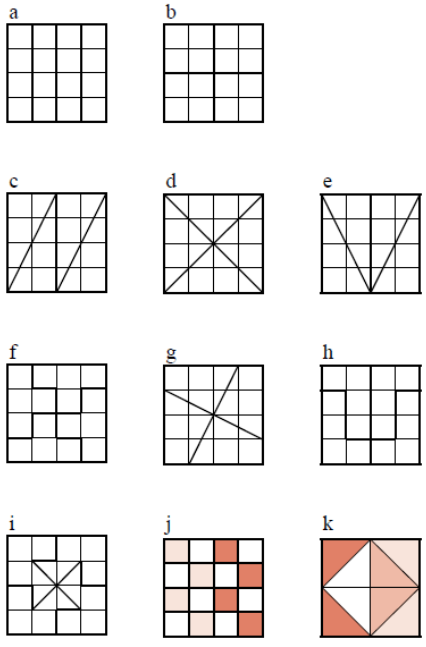

Figure 1. Examples of solution types (Hershkovitz et al., 2009)

Implementation of Math Teaching Practice

In order to attract and hold students' attention, the problem 'Four children have to share a square cake in a fair way. How will they cut the cake?' The problem is posed. With the answers received, the teacher introduces and mentions the general structure of the task, the necessary concepts such as diagonal, continuity and discontinuity, regularity and irregularity. The worksheet containing the problem and the information related to the problem is distributed to the students. This teaching activity focuses on three main questions:

- What kind of shapes appear when division is continuous and regular?
- What kind of shapes appear when division is continuous and irregular?
- What kind of shapes appear when you do division discontinuously?

As follows. In the activity, students are expected to develop and use a high-level mathematical perspective especially for the three questions. In addition, Aydın and Özdemir (2020) interpreted this example as providing all the features in terms of mathematical flexibility, fluidity and originality. Accordingly, necessary explanations were made to the students in the context of three different questions, and the drawings received from them are as follows.

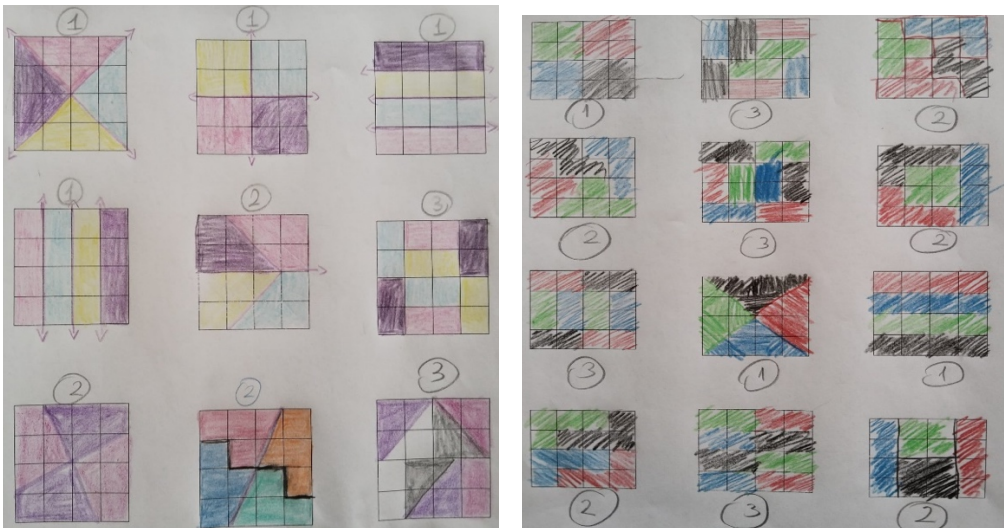

Figure 2. Sample drawings made by students-1

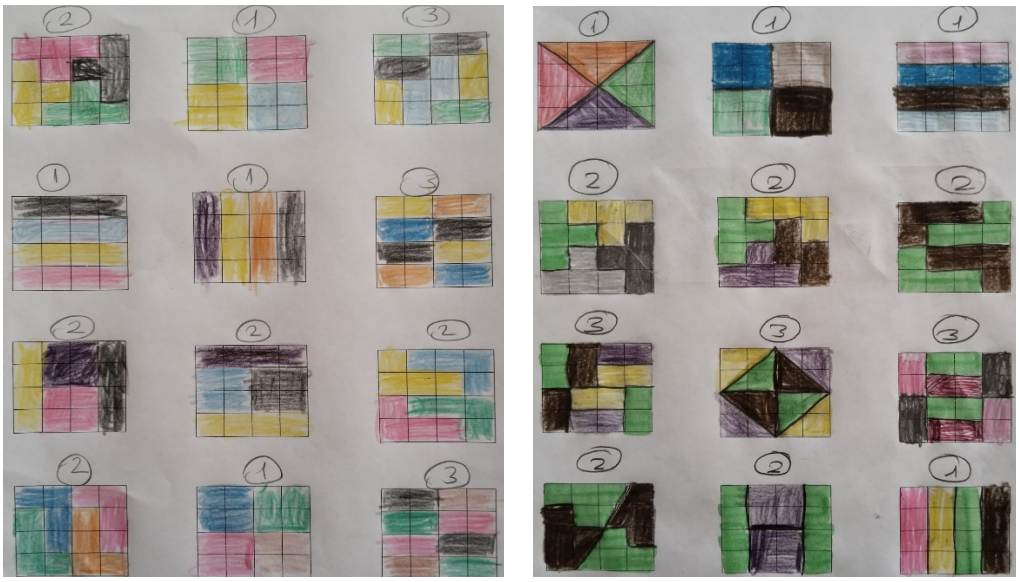

Figure 3. Sample drawings made by students-2

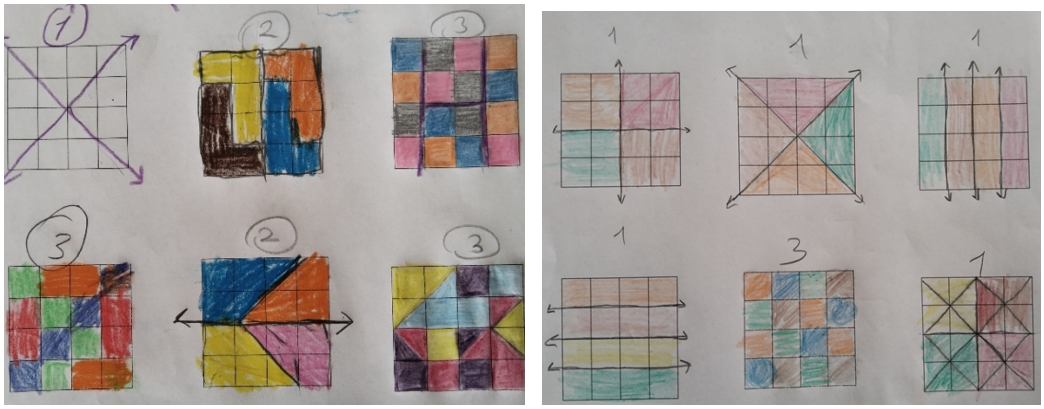

Figure 4. Sample drawings made by students-3

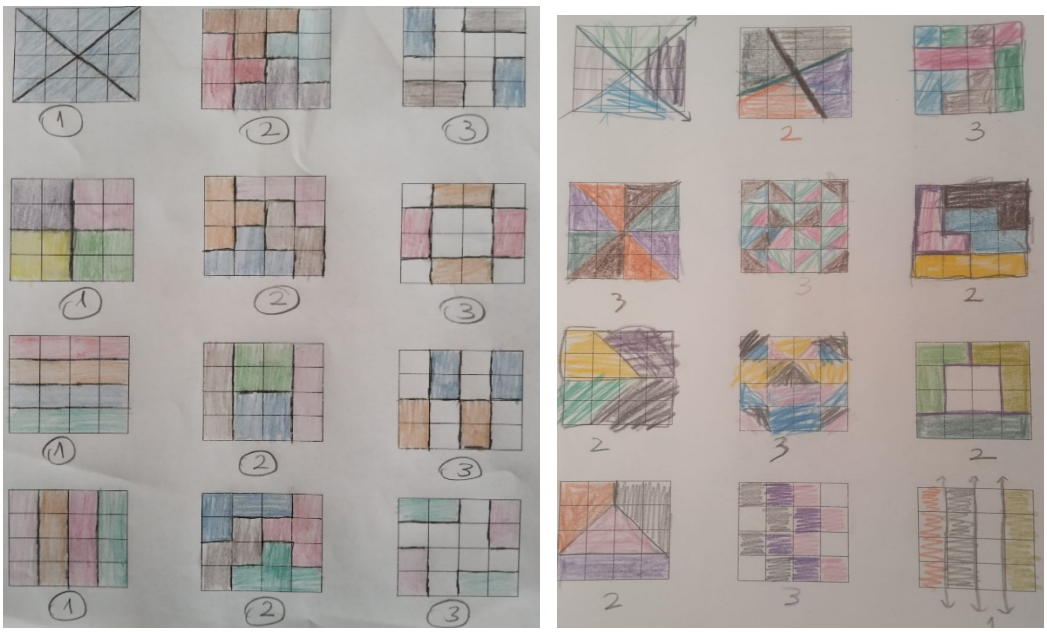

Figure 5. Sample drawings made by students-4

When the sample student drawings presented in the figures given above are analysed, it is seen that different types of drawings were made for each of questions 1, 2 and 3. It is seen in the students' drawings that they interpreted the questions and the problem from different perspectives. As seen in the drawings, many students coloured their drawings. In addition, each of the students wrote how many numbered questions they drew within the scope of the question around each of their drawings. As can be seen in the drawings, students generally focused on unit squares and performed division, while a few students focused on half squares or larger triangles.

Finally, the graph expressing the distribution of student drawings in the context of three different questions is presented below.

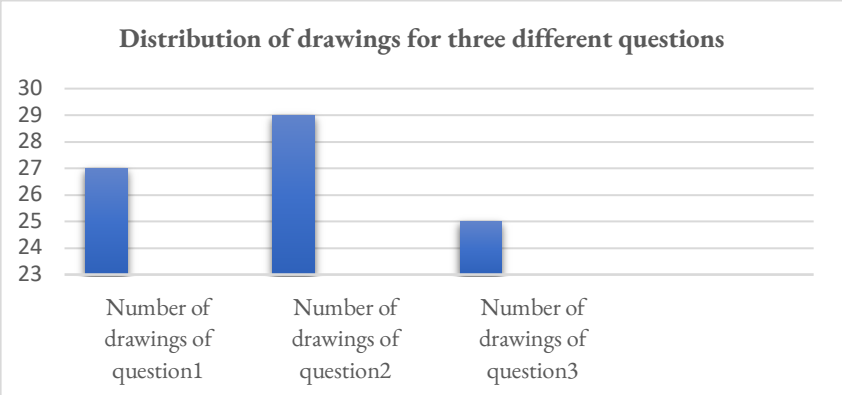

Figure 6. Distribution of drawings for three different questions

When the graph given above is analysed, it can be stated that the student drawings are mostly concentrated in the context of question number two.

Conclusion

It is important to develop the mathematical creativity of gifted students and to carry out teaching activities that can offer them multiple perspectives. In particular, it was determined that the students developed a high level mathematical perspective and proposed new types of solutions for the three questions asked in the activity. Moreover, as an important result, this teaching activity provided students with a different perspective in terms of mathematical flexibility, fluidity and originality. By analysing all the drawings of the students, it was concluded that they consciously performed the desired operation of each problem. In particular, it was also concluded that the student drawings were mostly concentrated in the context of question number two. Based on all the results expressed, the activity can be applied with more gifted students at different grade levels. In addition, this teaching activity can also be carried out with groups of students who are not gifted.

Limitations of Study

This teaching practice was carried out with 4th grade students attending the support education programme in a science and arts centre. This situation is a limitation in terms of a single institution, a single grade level and a small number of participants in the teaching practice.

Acknowledgment

Required permissions were obtained from Ali Kuşçu Science and Art Centre for the implementation of this teaching practice. Necessary explanations were made to the participating students and the principle of voluntary participation was complied with. In addition, the necessary individual permissions were obtained from the students with the voluntary participation form and from their parents with the parental consent form. Personal information was not included in the teaching practice, and no images or data were used without permission.

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