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Creative Models of Junior High School Students in Solving Open Ended Mathematical Problems on Keirsey Personality Types

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ABSTRACT

This research is based on the 21st century 6Cs skills, namely character, citizenship, critical thinking, creativity, collaboration, and communication. Student personality or more broadly, character, contributes to the variation in students' creative outcomes. In this study, creativity is assessed through three aspects of the creative model: imitation, modification, and creation. The creative model is explored through open-ended mathematical problem-solving. This qualitative descriptive research aims to describe students' creative models in open-ended mathematical problem-solving in relation to their Keirsey personality types. The study was conducted at MTS Negeri Kota Batu, with 4 out of 27 seventh grade students selected as research subjects using a Keirsey personality type questionnaire, which categorized them as guardian, artisan, rational, and idealist. The results indicate that the guardian subject only exhibited one aspect, namely modification, which was still at a low level. The artisan subject demonstrated moderate imitation and very low modification. The rational subject showed moderate imitation, high modification, and high creation. The idealist subject exhibited moderate imitation, moderate modification, and high creation. Based on these findings, it can be concluded that two subjects with idealist and rational personality types fulfilled all three aspects of the creative model, while the other two subjects, with artisan and guardian personality types, only fulfilled the imitation and modification aspects.

Keywords: creative model; keirsey personality types; open-ended mathematical problem solving

INTRODUCTION

The 6C competencies (character, citizenship, critical thinking, creativity, collaboration, and communication) are essential skills needed in the 21st century (Anugerahwati, 2019; Junaidi et al., 2020; Sari et al., 2021). Contemporary education is expected to foster the development of student creativity in Indonesia (Kenedi, 2017). However, based on PISA results, Indonesian students' achievements are still below the international average (Hartono et al., 2021; OECD, 2022). This is in line with previous research by Utari et al., (2024) & Yenti et al., (2023) conducted at MTs which revealed that students' creativity levels were still categorized as moderate or sufficient and low, thus limiting their ability to generate alternative solutions to problems independently. One of the contributing factors is the variety of student creativity models, namely imitating, modifying, and creating (Atmaja et al., 2023; Subanji et al., 2021; Subanji & Nusantara, 2022). One way to overcome the challenge is the use of open-ended problems (Leikin & Elgrably, 2022; Widiastuti & Imami, 2022). Such problems can stimulate or encourage students' use of reasoning and creative thinking (Sullivan et al., 2013:58). Especially on the topic of two-dimensional geometry using open-ended problems is considered appropriate, because geometry concepts are often applied in real-life contexts which can facilitate the

development of student creativity (Amri et al., 2024; Elia et al., 2018; Pradiarti et al., 2024; Pratiwi et al., 2023).

Referring to previous studies, researchers made initial observations at MTs Batu City. Through interviews with teachers and getting results that identified problems related to low student creativity. Based on the identification of these problems, the researchers investigated this problem further by conducting a preliminary study by giving open-ended geometry problems to 27 students. The results showed that 20 students showed creativity in the form of imitation, 5 students showed modification, and only 2 students reached the creation level. These findings indicate that students use diverse approaches to solving problems, reflecting different creativity characteristics that are closely related to individual personality types (Gajda, 2016; Hemdan et al., 2023).

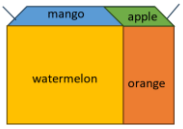
Personality types classified as Guardian, Artisan, Rational, and Idealist represent unique and relatively stable internal and external factors within a person and they play an important role in shaping creative answers (Keirsey, 1998; Keirsey & Bates, 1984). Based on the results of preliminary studies and previous research, creative thinking through student creativity models needs to be explored more deeply by considering their personality types, because differences in personality traits result in diverse manifestations of creative thinking among students or get different answer results.

RESEARCH METHODS

This study employs a qualitative descriptive research approach and was conducted at MTs Negeri Kota Batu. Subjects were selected through purposive sampling, using the Keirsey personality questionnaire. The Keirsey Personality Questionnaire, an assessment tool for personality developed by David Keirsey, is known as the Keirsey Temperament Sorter (KTS) (Keirsey, 1998). Unlike other personality indicators, KTS emphasizes observable behaviors and preferences in interacting with the environment (Mulyastuti et al., 2019). The researcher considered students' written and oral communication methods and consulted with mathematics teachers to determine the research subjects. The research instruments included the Keirsey personality questionnaire to identify the subjects, an open-ended mathematical problem-solving test that aligns with the aspects of creative models in the topic of plane geometry, and semi structured interview guidelines designed to explore students creative models based on specific indicators. The aspects used in the creative model test are imitation, modification, and creation. The validity results for the instruments indicate that they are valid and suitable for use in this study. Below is Table 1, which contains the open-ended mathematical problem-solving questions.

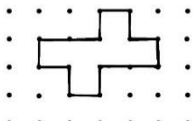
Table 1 Open-ended mathematical problem-solving questions

1. Mr. Ali's open land will be planted with flat fruit as follows:  On the land, Mr. Ali divided it into several flat shapes as in the following example (the original flat shape was divided into 4 flat shapes):



Make 2 sketches on Mr. Ali's land consisting of 3 to 6 different types of flat shapes.

2. Draw 1 to 4 different flat shapes with the same area as the following image, with the distance between each point being 1 cm.



3. Mr. Ahmad is a renowned landscaper in his area. One of his clients, Mr. Budi, has requested a garden for his rectangular backyard, which measures 12 meters in length and 8 meters in width. The plan is to transform the entire area into a flower garden to enhance the beauty of the backyard.

Please create a shape that has the same area as Mr. Budi's backyard. You may design a single shape or a combination of 2 to 4 shapes. Use different shading for each shape to represent various types of flowers, ensuring that the total area of all shapes equals the area of Mr. Budi's backyard.

This study employs the data analysis technique developed by Miles and Huberman, which consists of three main steps: data reduction, data display, and conclusion drawing. The data is presented as descriptions of students' responses to open ended math problems, analyzed through the framework of Keirsey personality types. Below is Table 2, which outlines the scoring rubric for open-ended mathematical problem solving, adapted to the creative model.

Table 2 assessment rubric for open-ended mathematical problem solving

Aspect	High	Medium	Low	Very Low
Imitation	One of the student's answer sketches can construct ≥6 different plane shapes.	One of the student's answer sketches can only construct 5 different plane shapes.	One of the student's answer sketches can only construct 4 different plane shapes.	One of the student's answer sketches can only construct 3 different plane shapes.
Modification	The student can construct ≥4 different plane shapes with the same area.	The student can only construct 3 different plane shapes with the same area.	The student can only construct 2 different plane shapes with the same area.	The student can only construct 1 different plane shape with the same area.
Creation	The student can construct ≥3 combinations of plane shapes with an equal total area.	The student can only construct 2 combinations of plane shapes with an equal total area.	The student can only construct 1 combination of plane shapes with an equal area calculation.	The student can only construct ≥1 plane shape with the same area, but without calculation details.

RESULTS AND DISCUSSION

This research focuses on students' creative models in solving open ended mathematical problems, viewed through the lens of Keirsey personality types. Subjects were selected based on the Keirsey personality questionnaire administered to students with the researcher selecting subjects from the personality types of Idealist, Artisan, Guardian, and Rational. The fundamental difference according to (Agustin, 2018) from the Keirsey personality type can be seen in its characteristics found in the guardian type, which is conservative, consistent, and meticulous. The artisan type is relaxed, acts economically without effort, and generally enjoys life. The idealist type is creative, imaginative, and insightful. The rational type is abstract, analytical, curious, and logical. Open ended mathematical problem solving test incorporating aspects of the student creative models was given to seventh grade students.

Idealist (IBR)

The IBR creative model can be o bserved through the process of solving open ended problems on plane geometry, completed by IBR according to the aspects of the creative model. A snapshot of IBR's answer for the Imitation aspect is presented in Figure 1.

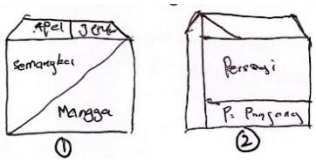


Figure 1. IBR Answer (Imitation)

Based on Figure 1, IBR understands the problem well. IBR smoothly provided answers by creating two sketches of Mr. Ali's plot. This is supported by the following interview excerpt:

P: What steps did you take to get the idea from the initial shape to create a new plane figure in this form (pointing to the student's answer)? Please explain.

IBR: First, I looked at the example problem, sir. From there, I drew two sketches dividing it into four sections like the example, and then into five sections.

P: Is the shape you divided the figure into the same as in the example?

IBR: It's different, sir.

Next, the modification aspect is presented in Figure 2.

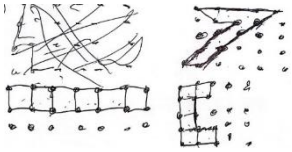


Figure 2. IBR Answer (Modified)

Based on Figure 2, IBR has a good understanding of the problem. IBR smoothly provided answers by creating a plane figure with the same area as the problem. This is supported by the following interview excerpt:

P: What steps did you take to change the plane figure from the example to the new one in your answer (pointing to the student's first answer)? Please explain.

IBR: First, I looked at the problem and saw that each point had a distance of 1 cm. Then, I divided it into squares, which gave me 6 squares, and I ended up with this shape, like the letter U.

P: How did you combine multiple solutions (pointing to the first to third student answers, if any) to create a new shape different from this plane figure (pointing to the student's second to fourth answers, if any)?
IBR: Since it was already divided into squares as I did earlier, the method is the same, then I drew it like this (pointing to the second answer), forming the number seven, although I had difficulty adjusting it to match the 6 squares like in the example.
Next, the creation aspect is presented in Figure 3.

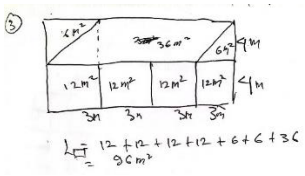


Figure 3. IBR Answer (Creation)

Based on Figure 3, IBR demonstrates the Creation aspect by solving the problem using a method different from his peers, which is unique. IBR smoothly provided an answer by first calculating the area of the rectangle as requested in the problem, then drawing the rectangle and dividing it into several plane figures. Let's review the following interview excerpt:
P: How did you come up with the idea to develop the plane figure like this (pointing to the student's answer)? Please explain how you got this idea.
IBR**:** After reading the problem, I was asked to create a garden. Then I thought of dividing the backyard of the customer into several sections with lines.
P: What steps did you take to create/find this new alternative solution (pointing to the student's answer)?
IBR: First, I calculated the area of the rectangle, then... I made another rectangle and divided it like this.

The analysis of the three aspects of IBR creative model within the Idealist personality type reveals that this type encompasses all three elements of the model. Specifically, the imitation aspect is moderate, the modification aspect is also moderate, and the creation aspect is high. The Idealist personality demonstrates its greatest creativity in the creation aspect. This observation is consistent with Keirsey, (1998:120) of Idealists as "creative," "enthusiastic," "humanitarian," "imaginative," "broad-minded," "religious," "subjective," and "sympathetic." Overall, this clearly indicates that all aspects of the creative model are represented in IBR analysis.

Artisan **(QNA)**

The creative model of QNA can be seen from the process of solving open ended questions on flat geometry material that has been worked on by QNA which is adjusted to the creative model aspect. A snippet of the QNA answer results for the Imitation aspect is presented in Figure 4 below.

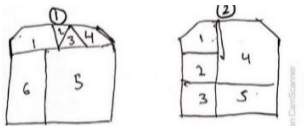


Figure 4. QNA Answer (Imitation)

Based on Figure 4, QNA understands the problem well. QNA smoothly provided an answer by creating two sketches of Mr. Ali's plot. This is supported by the following interview excerpt:

P: What steps did you take to get the idea from the initial shape to create a new plane figure like this (pointing to the student's answer)? Please explain.

QNA: I looked at the example and then divided it into 5 and 6 shapes in the two sketches (pointing to both answers).

P: How many different shapes are there?

QNA: For this one (pointing to the first sketch), there are... (counting) 4, sir, because there are two triangles and the trapezoid.

P: How about the other one (pointing to the second answer)?

QNA: There are just 3 sir, like before with the same shapes: squares and trapezoids.

Next, the modification aspect is presented in Figure 5.

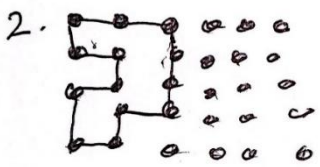


Figure 5. QNA Answer (Modified)

Based on Figure 5, QNA understands the problem well. QNA provided a good answer by creating a plane figure with the same area as the one in the problem. This is supported by the following interview excerpt:

P: What steps did you take to change the plane figure from the example to the new one in your answer (pointing to the student's answer)? Please explain.

QNA: I calculated it first, then I changed it into this figure (pointing to the answer).

The text discusses the three aspects of QNA creative model as they relate to the Artisan personality type. It concludes that only two aspects are present: imitation and modification, with the modification aspect being somewhat limited. The Artisan personality exhibits a moderate level of creativity in imitation but a very low level in modification. This limited creativity stems from a lack of enthusiasm for problem solving, which aligns with Keirsey, (1998:35) that Artisan individuals tend to be relaxed, economical in their efforts, and generally enjoy life. This mindset often leads them to complete tasks quickly, resulting in a tendency to rush (Agustin, 2018). Consequently, the Artisan personality does not fully grasp the intricacies of problems, which is why it only demonstrates moderate imitation and very low modification within the creative model.

***Realis* (QAF)**

The QAF creative model can be seen from the process of solving open ended questions on flat geometry material that has been worked on by QAF which is adjusted to the creative model aspect. A snippet of the QAF answer results for the Imitation aspect is presented in Figure 6.

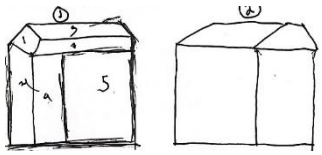


Figure 6. QAF Answer (Imitation)

Based on Figure 6, QAF understands the problem well. QAF smoothly provided an answer by creating two sketches of Mr. Ali plot. This is supported by the following interview excerpt:

P: What steps did you take to get the idea from the initial shape to create a new plane figure like this (pointing to the student's answer)? Please explain.

QAF: First, I drew this shape (pointing to the initial shape in the problem), and drew two according to what the problem asked. Then, for this one (pointing to the first student answer), I divided it into 6, but there are 5 different shapes because there are two trapezoids and for this one (pointing to the second student answer), I divided the shape into 4 different plane figures.

Next, the modification aspect is presented in Figure 7.

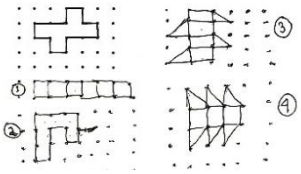


Figure 7. QAF Answer (Modified)

Based on Figure 7, QAF understands the problem well. QAF smoothly provided an answer by creating a plane figure with the same area as the one in the problem. This is supported by the following interview except:

P: What steps did you take to change the plane figure from the example to the new one in your answer (pointing to the student's answer)? Please explain.

QAF: I first looked at the problem, then I changed the example figure into this one (pointing to the first answer) which has the same size as the problem.

P: How did you combine several solutions (pointing to the first to third student answers, if any) to create a new shape different from this plane figure (pointing to the second to fourth answers, if any)?

QAF: I started from this (pointing to the first answer), then I played around with it to make 6 straight boxes, then I combined the boxes to get this (pointing to the third figure).

Next, the creation aspect is presented in Figure 8.

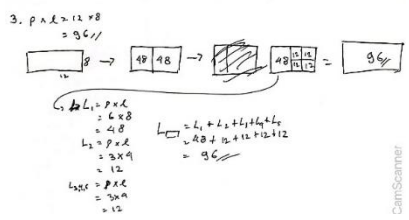


Figure 8. QAF Answer (Creation)

Based on Figure 8, QAF enters the Creation aspect by solving the problem using a method that differs from their peers, with a unique approach. QAF first divides the shape into two rectangles, then divides the second rectangle into 4 smaller ones, ensuring that the total area still matches the area of Pak Budi's backyard. QAF smoothly calculated the area

of the rectangle first as required by the problem and then drew the rectangle and divided it into several plane figures. To crosscheck, we look at the following interview excerpt:
P: How did you come up with the idea for this plane figure (pointing to the student's answer)? Can you explain how you came up with this idea?
QAF: First, I read the problem, and then I thought of dividing the garden into several plane figures.
P): How did you create/find this alternative solution (pointing to the student's answer)?
QAF: First, I calculated the area of the rectangle, then I drew the rectangle and divided it into four square plane figures, each with the same size as the rectangle

Based on the explanation of the three aspects of QAF creative model within the Rational personality it is evident that the Rational personality type exhibits all three aspects. The Rational personality achieves high levels of creativity in both the modification and creation aspects, which aligns with the characteristics described Keirsey, (1998:165) these characteristics include being abstract, analytical, competent, complex, curious, efficient, precise, intellectual, logical, theoretical, research-oriented, and systematic. Therefore, it is clear that the responses from the Rational personality type align with these traits, resulting in high level modification and creation. However, there is also room for improvement in understanding the problem and processing the thinking instructed by the question before immediately writing the abstract answer that comes to mind.

***Guardian* (ASEP)**

The creative model of ASEP can be seen from the process of solving the open-ended problem on plane geometry, which has been worked on by ASEP in accordance with the aspects of the creative model. A snippet of ASEP answer for the Imitation aspect is presented in Figure 9.

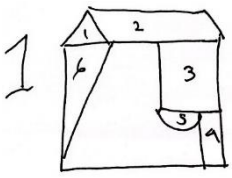


Figure 9. ASEP Answer (Imitation)

Based on Figure 9, ASEP has not clearly understood the meaning of the problem in the question. ASEP wrote an answer by only creating one sketch on Pak Ali yard. This information is supported by the following interview excerpt:
P: How did you come up with the idea from the initial shape to create a new plane figure like this (pointing to the student's answer)? Can you explain?
ASEP: aaaa, I looked at the example first, then I drew this shape (drawing the initial shape from the example), and then I drew again inside it with this shape, sir.
Next, the modification aspect is presented in Figure 10.

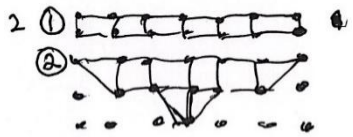


Figure 10. ASEP Answer (Modified)

Based on Figure 10, ASEP understands the problem in the question well. ASEP created two drawings with the same size as the one in the question, using different plane figures. This information is supported by the following interview excerpt:
P: How did you change the plane figure from the example to create the new one in this answer (pointing to the first student's answer)? Can you explain?
ASEP: I drew this shape first, sir, a rectangle, which I then cut into several smaller squares.
P: How did you combine the solutions (pointing to the first to third answers, if any) to create a new shape that is different from the plane figures in the answers (pointing to the second to fourth answers, if any)?
ASEP: After I formed the rectangle earlier, I changed this part and this part (pointing to the width of the rectangle). I cut it into triangles, and then placed half of it below the other half like this (pointing to the left and right sides of the rectangle).

Based on the explanation of the three aspects of creative models in ASEP answers, it is clear that ASEP a guardian personality and has only one aspect of creativity modification because in answer number 1 of the imitation aspect ASEP was not able to create two sketches but only made one. Although the answer can be evaluated according to the rubric in Table 2, it does not meet the instructions in the question, which require two sketches in answer number 1. This is due to ASEP lack of attention to detail when reading the instructions and a lack of enthusiasm in solving the problem. According Keirsey, (1998:78), individuals with a guardian personality are described as conservative, consistent, reliable, detailed, factual, hardworking, careful, patient, persistent, routine-oriented, rational, stable, precise, not easily distracted, and not impulsive. However, this contrasts with ASEP answer, where the main mistake in solving the open-ended question was the lack of precision and detail in understanding and solving the problem. ASEP mistake matches Hakim et al., (2022) research, which suggests that students with a guardian personality type struggle to complete their tasks thoroughly and clearly. This discrepancy aligns with the research Amalia, (2017) , which suggests that mistakes often occur due to poor comprehension of the question and a lack of attention to detail, which can lead to running out of time to complete the problem.

CONCLUSION

Based on the research results, the main conclusion is that the ability of junior high school students to solve open-ended mathematical problems on the topic of plane figures varies according to their Keirsey personality types, with different aspects of creative models emerging. Students with the Idealist personality type meet the imitation aspect at a moderate level, modification at a moderate level and creativity at a high level. Students with the Artisan personality type only exhibit two aspects: the imitation aspect at a moderate level and modification at a very low level. Subjects with the Rational personality type meet the imitation aspect at a moderate level, modification at a high level and creativity at a high level. Subjects with the Guardian personality type only display one aspect of the creative model, modification, at a low level. The results show that the work produced is insufficient, and the enthusiasm for solving the problems is low for students with Artisan and Guardian personalities. Therefore, it can be concluded that students with Idealist and Rational personality types cover all three aspects of the creative model, achieving good cognitive

results in solving open ended problems, while students with Artisan and Guardian personality types only cover two aspects due to a lack of precision and attention to detail.

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