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Solving Geometric Problems from the Perspective of Left and Right Brain Dominance

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Abstract

Problem-solving is an effort to find a way out of a difficulty so as to obtain a solution. Each child's problem-solving is different. This is influenced by the dominance of the brain in solving a problem. The purpose of this study is to describe the geometry problem-solving abilities of junior high school students in terms of left and right brain dominance. The research method is descriptive with a qualitative approach. The instruments used are test questions, questionnaires, and interview guidelines. The results show that students with left and right brain dominance types in solving geometry problems can fulfill all stages according to Gagne, which include Presentation of the problem, stating the problem in operational form, compiling work procedures, making hypotheses, and reviewing. The findings of students with left brain dominance in solving problems appear to be calmer and more patient, prefer to solve problems with formulas given by a teacher, need scratch paper in solving problems, tend to think with the chin supported by the right hand, and have neat writing. Meanwhile, students with right brain dominance in solving problems appear to move more, tend to have many ways, sometimes use their own way, work while speaking, and if they have scribbles, it will be very difficult to understand, and draw on blank paper with unclear images.

Keywords: Left Brain and Right Brain; Geometry; Problem-Solving.

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1. Introduction

Problem-solving ability is one of the essential skills students must possess to face various challenges in education, particularly in mathematics and geometry. According to Polya (1995), Rahman (2019); Angkotasan et al., (2024), problem-solving is a process involving systematic steps to find solutions to a problem. In an educational context, this ability not only functions to solve mathematical problems but also contributes to the development of students' critical and creative thinking skills. Research shows that students with good problem-solving skills tend to be more successful academically and have higher competitiveness in the future (Baron, 1986; Jäder et al., 2020).

The importance of problem-solving skills cannot be underestimated. In today's information age, students are required not only to master theoretical knowledge but also to be able to apply that knowledge in real-world situations (Azkiana et al., 2025; Wayudi et al., 2020). This ability is highly relevant in various fields, from science and technology to the arts. For example, in the workplace, companies prefer candidates who possess not only knowledge but also the ability to analyze and solve complex problems (National Research Council, 2012). Therefore, developing problem-solving skills among students should be a priority in the educational curriculum.

However, despite its importance, many students experience difficulties in problem solving, especially in geometry. According to research by Silmi Juman et al. (2022), approximately 60% of students experience difficulties in understanding geometric concepts and applying them in problem solving. This difficulty is often caused by a lack of understanding of basic concepts, an inability to connect information, or even anxiety about mathematics itself. Furthermore, students' problem-solving abilities vary due to the influence of brain dominance (Hayu & Angraini, 2024; Hiltrimartin & Pratiwi, 2025; Putri & Khadijatuzzahra, 2025; Supriyadi et al., 2024).

This shows that brain dominance is essential for problem-solving. The brain is the primary controller of the human body. The left brain is often associated with analytical skills, logic, and structured problem-solving, while the right brain is more associated with creativity, intuition, and holistic thinking (Klitgaard & Gardner, 1984); (Prastya et al., 2021). Research shows that students who are able to integrate these two types of thinking tend to be more successful in solving mathematical problems. For example, students who use a creative approach to understanding geometry are often better able to find innovative and effective solutions (Kaufman, 2009; Klau et al., 2022). Research related to problem-solving with left-brain and right-brain dominance is still very limited.his is illustrated by the following figure.

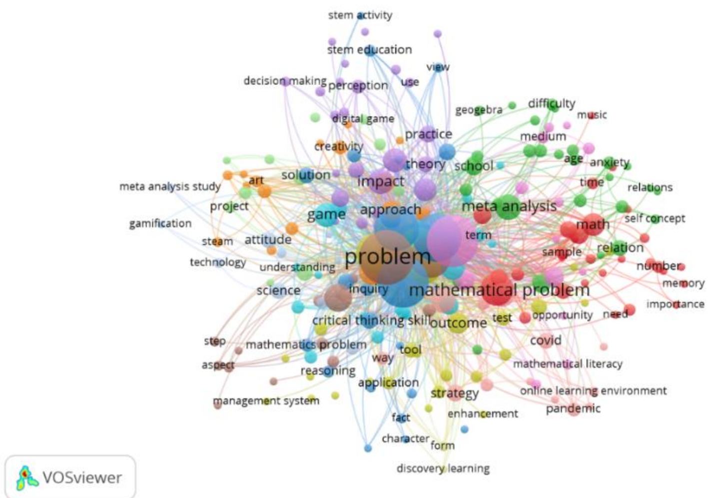

Figure 1 Vosviewer

Figure 1 shows that mathematical problem solving has a large circle, indicating that it has been highly favoured by researchers for the past 7 years. However, no apparent correlation has been observed between problem-solving and left-brain or right-brain dominance in any study. This is even though both left-brain and right-brain use significantly contribute to problem solving. Previous research has shown that an approach combining these two aspects can improve students' ability to solve geometric problems (Felder & Brent, 2005; Azizah et al., 2021). Given these gaps, this research is expected to make a positive contribution to the development of learning by teachers in schools.

2. Methods

The method used in this study was qualitative to describe students' geometry problem-solving abilities based on left-brain and right-brain dominance. The subjects in this study were eighth-grade junior high school students. The instruments used in data collection were problem-solving ability test questions, questionnaires, and interview guidelines. Data analysis refers to qualitative steps according to Miles & Huberman (1994); Fadli (2021), including data reduction, data presentation, and conclusion drawing.

3. Results and Discussion

The researcher took the eighth grade of junior high school as the research subject because the class had received learning about geometry material, especially on flat planes, and was considered suitable for observing their ability to solve problems based on Gagne's theory. The stages of problem-solving abilities according to Gagne (1980), Hafidz et al. (2019) include Presenting Problems, stating problems in operational form, preparing work procedures, making hypotheses, and reviewing. Of the 27 students who filled out the left and right brain dominance questionnaire, 16 students tended to use the right brain, and 9 students tended to use the left brain. Furthermore, all 27 students were given a geometry problem-solving ability test, and 4 students were able to provide correct solutions. The four students included 1 student from the right brain dominance category and 3 students from the left brain dominance category. The form of the questions given can be seen in the following figure.

A rectangular sheet of zinc measures 50 cm x 40 cm. The zinc is formed into a circular can lid with a radius of 20 cm. What is the area of the zinc used?

Figure 2 Test questions

The subjects were allocated 30 minutes to complete the given set of geometry problems under controlled conditions to ensure uniformity in time pressure and cognitive engagement. Immediately after the problem-solving session, the researcher conducted in-depth, semi-structured interviews with four purposively selected students to gain deeper insights into their reasoning strategies, decision-making patterns, and challenges encountered during the problem-solving process. The selection of these students was based on the variation in their performance outcomes, representing a spectrum of problem-solving approaches and levels of achievement. The interviews focused on eliciting detailed narratives about the steps they employed, the strategies they found most effective, and the obstacles that hindered their progress. The qualitative data obtained from these interviews were then triangulated with the students' written responses to strengthen the validity of the findings (Kania et al., 2025; Nisa, 2024). The following section presents a comprehensive description of the problem-solving skills demonstrated by the subjects in tackling geometry problems, supported by both written solutions and verbal explanations provided during the interviews.

3.1. Description of S1 Problem-Solving Ability with Left Brain Dominance Type

The results of the geometry problem-solving ability test of S1 subjects with left brain dominance can be presented as follows.

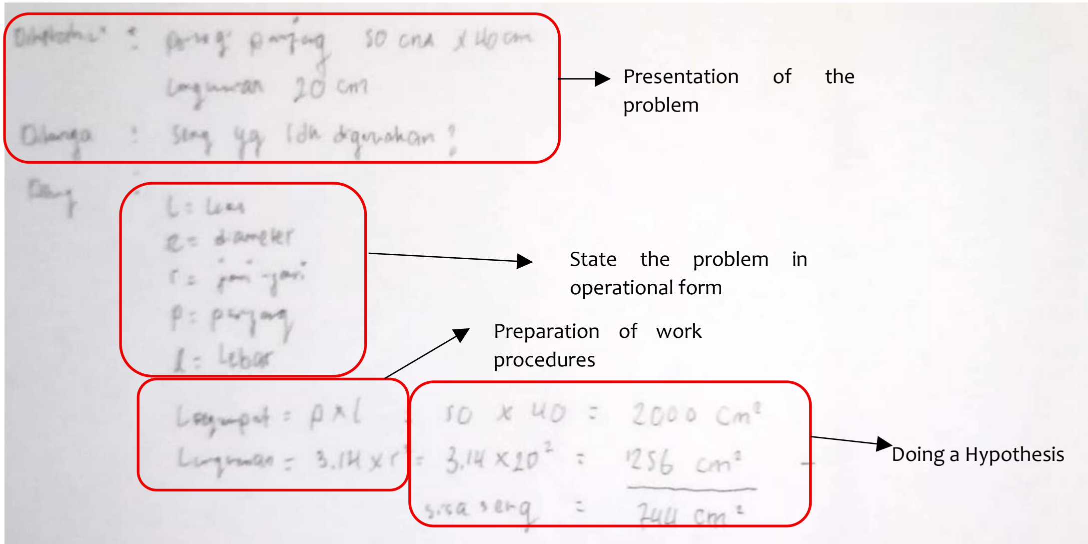

Figure 3 Results of S1 Work, Left Brain Dominance Type

Figure 2 shows the results of S1's work with a left-brain dominant type in solving geometry problems. The results show that S1 subjects can understand the problem very well, starting with restating the problem. S1 subjects wrote that the dimensions of the rectangle are 50 cm x 40 cm, and the radius of the circle is 20 cm. When asked about the area of the zinc used, this is in line with the subject's statement during the interview, as follows.

P	:	*What information is obtained from this question?*
S1	:	*Known rectangles and circles*
P	:	*What will be looked for in the question?*
S1	:	*What I'm looking for is the area of unused zinc.*
P	:	*Try to tell us about the problem you experienced in this question.*
S1	:	*The rectangle measures 50 cm x 40 cm, and the radius of the circle is 20 cm. The problem is the unused area of the zinc.*

In the context of geometry problem-solving, the left brain plays a significant role in analyzing the information provided, identifying patterns, and connecting relevant concepts. According to Jolly et al. (2020) in their research, individuals with left-brain dominance tend to be better at solving problems that require logical and mathematical thinking. Jolly et al. (2020) confirmed that approximately 70% of students who exhibit left-brain dominance successfully solve geometry problems, compared to 30% of students who exhibit right-brain dominance.

After presenting the problem, subject S1 began to state the problem in a more operational form. The left brain's ability to express problems in operational form is very important in the problem-solving process. Based on Figure 4.2, subject S1 can be seen writing several symbols that will be used in solving the problem. These symbols are L for area, π for diameter, r for radius, p for length and l for width. The written symbols will be formed into a mathematical formula to facilitate the solution. This is supported by the following excerpt from the subject's interview.

P	*:*	*What plan did you use in the solution?*
S1	*:*	*By determining L=area, π=diameter, r=radius, p=length, and l=width and making a mathematical model*
P	*:*	*What formula is used in this problem?*
S1	*:*	*Area of a quadrilateral and a circle*

This finding suggests that undergraduate students are capable of transforming verbal or situational problems into mathematically tractable forms, a critical step in effective problem-solving. Such an ability reflects students' competence in identifying relevant information, structuring it within a mathematical framework, and subsequently applying appropriate strategies to reach a solution. According to España-Irla et al. (2021), students who are explicitly trained to reformulate problems in operational terms demonstrate significantly higher success rates in solving geometry tasks. Their study reported that 85% of students who received such training successfully solved geometry problems, whereas only 50% of untrained students achieved comparable results. This evidence underscores the importance of structured training in problem representation, as it not only enhances procedural accuracy but also fosters deeper conceptual understanding. In line with this, the present study highlights the role of problem reformulation as a mediating factor between students' initial comprehension and their eventual problem-solving outcomes, suggesting that explicit instructional interventions targeting this skill could substantially improve students' performance in geometry.

The next step is to develop a work procedure. The left brain also plays a crucial role in developing a systematic work procedure for problem-solving. In developing the work procedure, subject S1 began by writing down the formulas for the area of a quadrilateral, which is pxl, and the area of a circle, which is $3.14 \times r^2$. The formulas were formulated by referring to the initial problem. According to subject S1, after obtaining the results for both areas, the two results were subtracted to find the remaining zinc. This is evident in the following interview excerpt from the subject.

P	*:*	*What method is used to solve this problem?*
S1	*:*	*By looking for Quadrilaterals and Circles first*
P	*:*	*Why choose that method?*
S1	*:*	*Because I prefer it this way*
P	*:*	*How do you solve this problem?*
S1	*:*	*The first is to write L of the rectangle = p x l, L of the circle = πr2 = 3.14 x r x r. Then determine the remaining zinc = L rectangle - L circle*

This indicates that undergraduate students have developed clear and structured steps to reach solutions. According to Wu et al. (2022), students who follow systematic work procedures in solving geometry problems tend to be more efficient and accurate in their solutions. Data shows that 78% of students who follow structured work procedures successfully solve problems in a shorter time compared to those who do not follow such procedures. In line with the opinion of Hanks et al. (2019), students who follow systematic steps in solving geometry problems show a significant increase in conceptual understanding compared to students who do not follow such procedures.

After compiling the work procedure, subject S1 then began to solve the problem. Based on Figure 4.2, it appears that subject S1 applied the formula by substituting the appropriate information. The result obtained by S1 from multiplying 50 by 40 is 2000 cm^2 as the area of the rectangle. Furthermore, for the area of the circle, 1256 cm^2 is obtained based on the operational process of 3.14 with 20 to the power of 2. The results obtained from both areas are then subtracted to obtain the remaining zinc, which is 744 cm^2. This shows that subject S1 can apply the formula well in finding the desired final solution. This is as expressed by subject S1 during the interview as follows.

P	:	*Explain the steps to solve this problem?*
S1	:	*The first step is to perform an example and enter the formula for the area of a quadrilateral and the area of a circle. Then, the next step is to work as shown in the answer below.* *Lquadrilateral = p x l = 50 x 40 cm = 2000cm2* *Lcircle = πr2 = 3.14 x 20 x 20 = 1256 cm2.* *Then determine the remaining zinc = 2000 – 1256 = 744 cm2*
P	:	*Is there another way to do this problem?*
S1	:	*No, I don't know*
P	:	*How long does it take to do this question?*
S1	:	*It doesn't take long.*

The work procedures carried out by the undergraduate subjects proceeded smoothly due to the effects of the previous hypothesis proposal. The left brain plays a significant role in forming logical and measurable hypotheses. According to Adnan et al., (2019), students trained to develop hypotheses tend to be better at solving complex problems. This is in line with the opinion of Gualtieri & Finn (2022), who found that students who actively propose hypotheses during the learning process have a deeper understanding of geometric concepts.

The final stage in the problem-solving process is reviewing. In this step, Subject S1 reviewed the problem-solving process but found no errors. Subject S1 stated that the final result was correct. Although Subject S1 did not write a conclusion at the time of completion, Subject S1 was able to demonstrate this during the interview. This is supported by the following interview excerpt.

P	:	*Have you checked your work again?*
S1	:	*Yes, I have seen it*
P	:	*Are you sure about your answer?*
S1	:	*Yes, I am sure*
P	:	*Show?*
S1	:	*Namely by searching Lquadrilateral = p x l = 50 x 40 cm = 2000cm2* *Lcircle = πr2 = 3.14 x 20 x 20 = 1256 cm2.* *Then the subject determines the remaining zinc = 2000 – 1256 = 744 cm2 then value Lquadrilateral – Lcircle =744cm2*

Reflection, or the process of systematically reviewing completed work, constitutes a crucial stage in the problem-solving cycle. Cognitive research indicates that reflection enables learners to re-evaluate the strategies employed, identify potential errors, and refine subsequent approaches. Neurological perspectives further suggest that the left hemisphere of the brain plays a significant role in logical sequencing and analytical re-examination of problem-solving steps, thereby supporting the reflective process. As noted by Jansen (2020), students who engage in structured reflection following the completion of geometry problems demonstrate notable improvements in both conceptual understanding and procedural fluency. Within the context of this study, undergraduate students (S1) exhibiting left-brain dominance were able to successfully navigate all stages of problem-solving as conceptualized by Gagné. These stages include: (1) presenting the problem, (2) reformulating it in operational terms, (3) designing systematic work procedures, (4) formulating and testing hypotheses, and (5) reviewing outcomes through reflective evaluation. This finding not only confirms the relevance of Gagné's theoretical framework in describing students' problem-solving processes but also highlights reflection as an essential cognitive activity that consolidates learning and promotes transferability to novel problem situations.

3.2. Description of Problem-Solving Ability of S2 with Right Brain Dominance Type

The results of the geometry problem-solving ability test of S2 subjects with right brain dominance can be presented as follows.

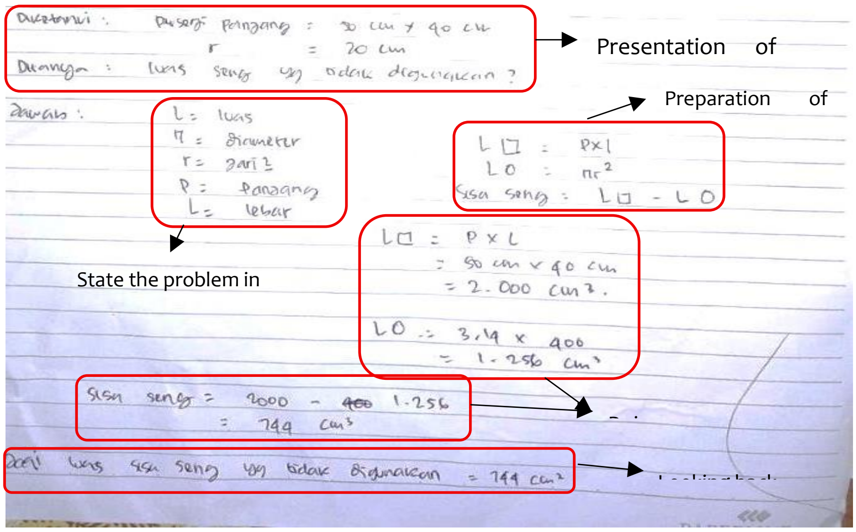

Figure 4 Results of S2 Work for Right-Brain Dominance Type

Figure 4 shows that the right-brain dominant subject S2 begins problem-solving by first understanding the problem. This understanding is demonstrated by writing down all the information contained in the problem more simply. The information written down is the known dimensions of the rectangle, namely 20 cm x 40 cm and r equal to 20 cm. Next, S2 writes down the question, namely, the area of the unused zinc. This shows that subject S2 can present all information by identifying things that are known. To strengthen this statement, an excerpt from the subject's interview can be presented as follows.

P	:	*What information is obtained from this question?*
S1	:	*Rectangle and circle*
P	:	*What will be sought from this question?*
S1	:	*What will be sought is the unused zinc area.*
P	:	*Tell us about the problem you experienced with the question.*
S1	:	*Initially confused about determining the area of zinc that is not used, but can be worked on*

Individuals with right-brain dominance tend to understand visual and spatial concepts better. According to Gualtieri & Finn (2022), children with higher cognitive abilities tend to use creative approaches in solving geometry problems, indicating that their right brain is more active in the learning process. A study conducted by Mohd Yatim et al. (2022) showed that students taught using a right-brain-based approach in learning geometry tend to experience significant improvements in conceptual understanding compared to traditional methods. The problems presented must include the use of visual tools to help students understand the relationships between various geometric elements. In line with Lusiana & Andari (2020), approximately 70% of students involved in visual-based learning experienced significant improvements in their learning outcomes.

After presenting the problem, the subject began to simplify the problem into a simpler and more operational form, namely by using symbols. The symbols used by the subject were L for area, π for diameter, r for radius, p for length, and l for width. According to the subject, the symbols used as a substitute for unknown values make it easier to solve. This is as expressed by the subject during the interview as follows.

P	:	*What are the initial steps used in solving the problem?*
S1	:	*By determining L = Area, π = diameter, r = radius, p = length, and l = width, and making a mathematical model.*
P	:	*What formula is used in this problem?*
S1	:	*I use the Area of a rectangle and a circle*
P	:	*Why use these symbols?*
S1	:	*Emm because it is related to the formula for rectangles and circles*

The symbols expressed by the subjects refer to the visualization process of the existing problem. According to Manik et al., (2024); Aisyah & Rahma (2024), students who use visualization techniques to express geometric problems can produce more innovative and effective solutions. This suggests that the right brain can assist in transforming abstract problems into more concrete and understandable representations.

The next step is to develop a work procedure. The process of developing a work procedure in solving geometry problems depends heavily on an individual's ability to think creatively and flexibly. In developing the work procedure, subject S2 began by writing down the formulas for the area of a square and a circle, as well as the remaining zinc to be found. The area of a square is p x l, the area of a circle is πr^2, and the remaining zinc is the area of the square minus the area of the circle. The subject created the square and circle shapes in the form of symbols as shown in Figure 3. This is reinforced by the following interview with the subject.

P	:	*What method is used to solve this problem?*
S1	:	*By finding the L-rectangle and L-circle first*
P	:	*How do you solve this problem?*
S1	:	*First, write down Lsquare and Lcircle. Then, I look for the remaining zinc result = Lrectangle - Lcircle.*

This finding suggests that S2 subjects demonstrate the ability to effectively develop systematic work procedures when solving geometry problems. Such competence may be attributed to the cognitive strengths associated with right-hemisphere dominance, which plays a pivotal role in fostering creativity, spatial reasoning, and flexibility in constructing alternative strategies. Adnan et al. (2019) emphasize that individuals with right-brain dominance are generally more adept at designing unconventional yet effective problem-solving procedures, thereby expanding the range of potential solutions. Consistently, Van den Heuvel et al. (2023), reported that approximately 75% of students engaged in creativity-based learning were able to develop superior work procedures in tackling geometry tasks compared to their peers in traditional instructional settings. Taken together, these findings underscore the contribution of right-brain functioning to the development of innovative and efficient work procedures. More importantly, they highlight the pedagogical potential of leveraging creativity-oriented approaches in mathematics education, where students are encouraged not only to follow conventional algorithms but also to design and adapt procedures that align with their cognitive strengths. This integration of creative thinking into procedural development ultimately has the potential to enhance students' problem-solving performance and learning outcomes in geometry.

After compiling the work procedure, subject S2 began to hypothesize by substituting the information into the formula created. Furthermore, through calculations, it was obtained that the area of the square was 2000 cm^2 and the area of the circle was 1256 cm^2. Meanwhile, the remaining zinc obtained through the calculation process was 744 cm^2. The subject's calculation process was carried out very well, so that it obtained the correct result. In addition, the procedure in the completion process was carried out in stages until the final result. This is reinforced by the following excerpt from the interview with subject S2.

P	:	*Please explain how you solved the problem.*
S1	:	*I input the formula* $L_{rectangle}$ *dan* L_{circle}*, then I do it like this*
		Lrectangle = p x l = 50 x 40 cm = 2000cm^2
		$L_{circle} = \pi r^2 = 3.14 \times 20 \times 20 = 1256\ cm^2$.
		Then subject determines the remaining zinc = 2000 – 1256 = 744 cm^2
P	:	*How confident are you in this answer?*
S1	:	*I am very confident*
P	:	*How long does it take to do this question?*
S1	:	*It doesn't take long.*

The subject's ability to execute hypotheses is well-executed because it refers to established work procedures. Individuals with right-brain dominance are often better able to think outside the box, allowing them to generate unique and interesting hypotheses. According to Jolly et al. (2020), students who use a creativity-based approach to hypothesizing in a geometric context can generate more innovative solutions. Statistical results show that approximately 80% of students involved in creativity-based learning can propose better and more relevant hypotheses compared to those who do not use this approach (Guo et al., 2014; Peng et al., 2021).

The final stage in problem-solving is review. During the review process, subject S2 reviewed the entire solution process, each step of the way. The review results showed no errors, so the subject was confident in the final result. Subject S2 then decided to conclude the solution, as shown in Figure 3. This is supported by the following interview excerpt from the subject's interview.

P	:	*Have you checked your work again?*
S1	:	*Yes, I have seen it*
P	:	*Are you sure about your answer?*
S1	:	*Yes, I am sure*
P	:	*Show?*
S1	:	*Namely by searching Lrectangle = p x l = 50 x 40 cm = 2000cm2*
		Lcircle = πr2 = 3.14 x 20 x 20 = 1256 cm2. Then I looked for Residual zinc = 2000 – 1256 = 744 cm2 Then value Lrectangle – Lcircle =744cm2

Subjects' confidence in their final answers is based on the reflection process they have undertaken. Right-brain-dominated individuals are often better able to reflect on the problem-solving process creatively and reflectively. According to Wu et al. (2022), students who use a reflective approach to geometry learning can more effectively identify errors and areas for improvement. They can reflect on the process they have gone through and relate those experiences to relevant geometric concepts, allowing them to develop a deeper understanding. Consistent with (Wibawa et al., 2025; Zhao et al., 2021), approximately 70% of students engaged in reflection-based learning can improve their ability to reflect on problem-solving outcomes.

Thus, based on each stage passed in the problem-solving process, it can be concluded that S2 subjects with a right-brain dominant type tend to fulfill all the problem-solving indicators according to Gagne, namely presenting problems, stating problems in operational form, compiling work procedures, making hypotheses, and reviewing.

4. Conclusions

Based on the results and discussion, it can be concluded that students with left and right brain dominance types in solving geometry problems can fulfill all stages according to Gagne, which include Presentation of problems, stating problems in operational form, compiling work procedures, conducting hypotheses, and reviewing. The findings of students with left brain dominance in solving problems appear calmer and more patient, prefer to solve problems with formulas given by a teacher, need scratch paper in solving problems, tend to think by supporting their chin with their right hand, and have neat writing. Meanwhile, students with right brain dominance in solving problems appear to move more, tend to have many ways, sometimes use their own way, work while speaking, while having scribbles, it will be very difficult to understand, and draw on blank paper with unclear images.

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Conflict of Interest

The authors declare no conflict of interest.

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