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Creative Thinking Process and Brain Dominance: Divergent and Convergent Thinking in Originality and Elaboration

Bayu Sukmaangara[1], Muhamad Gani Rohman[2]
[1]Universitas Islam Negeri Siber Syekh Nurjati Cirebon, Cirebon, Indonesia
[2]Universitas Islam Negeri Salatiga, Kota Salatiga, Jawa Tengah

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ABSTRACT

The creative thinking process results from the interaction between divergent and convergent thinking, which complement each other and are influenced by brain hemisphere dominance in processing information. The emphasis on originality and elaboration in this process demonstrates that each individual possesses unique problem-solving tendencies, making them worthy of focus in educational research. This study aims to describe the processes of divergent and convergent thinking in mathematical creative thinking, with a focus on originality and elaboration based on brain dominance. The research method employed was qualitative, with a descriptive and exploratory approach. The sample consisted of 3 students, selected for in-depth analysis from a total of 31 students. The instruments used were mathematical creative thinking, brain dominance tests, and unstructured interviews. Data were analyzed through data reduction, presentation, and conclusion. The study's results showed that students with left-brain dominance relied more on convergent thinking processes when solving problems. Conversely, students with right-brain dominance tend to prioritize divergent thinking. Students with balanced brain dominance showed a relatively balanced ability in using both thinking patterns. These findings provide educators with an overview of how to design questions that encourage thinking processes involving both divergent and convergent thinking, tailored to students' brain dominance, to optimize learning outcomes.

Corresponding Author:

Bayu Sukmaangara
Fakultas Ilmu Tarbiyah dan Keguruan, Mathematics Education, Universitas Islam Negeri Siber Syekh Nurjati Cirebon
E-mail: bayusukmaangara@uinssc.ac.id

1. INTRODUCTION

Researchers conducted a preliminary study by presenting a problem in finding the volume of a flat-sided geometric figure. The results of this preliminary study demonstrated that students' thinking processes differ. This finding is also supported by research by Yohanes, which revealed that the students' thinking processes in the study exhibited different patterns [1]. The diverse thought processes of students demonstrate that students' thoughts and thought processes are distinct. The thinking process can assess someone about what and how thoughts are produced [2]. Teachers assess what and how students think, enabling them to understand how students approach problem-solving. Teachers know what students think can maximize the learning process.

Teachers can create learning plans that align with students' thinking processes by understanding their creative thinking styles [3]. Teachers must understand students' creative thinking processes in solving problems so that the planned learning process achieves maximum results. The importance of creative thinking processes in the learning process was stated by Botella, Zenasni, and Lubart, who studied "What Are Stages of the Creative Process? What Visual Art Students Say" with research results that creative thinking processes in art classes can help art educators develop students in the field of art [4]. Teachers can more easily guide and direct students on what they want to learn. Direction and guidance have a significant impact on the development of students' creative potential.

Another reason why creativity is important is that it is also a factor that students must possess to face the challenges of educational transformation in the 21st century. The development of 21st-century education requires students to be able to produce innovative breakthroughs. Creativity is essential for competing in the development of education in the 21st century, enabling the production of innovative breakthroughs. Trilling and Fadel state that one of the skills needed in the 21st century is the ability to learn and innovate, which must enable the development of creativity to produce innovative breakthroughs [5].

Guilford introduced two types of thinking patterns in creativity, namely divergent thinking and convergent thinking [6]. Creativity requires both divergent thinking and convergent thinking, without diminishing the importance of either. Divergent thinking plays a role in generating new ideas, while convergent thinking is responsible for selecting and linking those ideas to solve problems. These two types of thinking complement each other in creative problem-solving. Brophy provides an explanation that true creative results do not only require divergent thinking, but convergent thinking is also needed to complement it [7]. Thus, both types of thinking are necessary in the creative thinking process to solve problems effectively.

The creative thinking process is not intended to measure an individual's level of creativity, but rather to outline the stages involved in the problem-solving process. The framework proposed by Wallas offers a clear structure for understanding how creativity unfolds. According to Sriraman, this stage-based model serves as a useful tool for identifying the phases of creative thinking [8]. Similarly, Savic acknowledged that the model introduced by Graham Wallas provides a practical approach to examining how individuals engage in creative thought [9]. In academic discussions, this framework is commonly referred to as the Wallas stages.

Wallas' model of creative thinking consists of four key stages: preparation, incubation, illumination, and verification [9]. Each of these stages involves the interplay of both divergent and convergent thinking processes [6]. The table below illustrates how these types of thinking correspond to the Wallas stages and serves as a reference for identifying specific indicators:

Table 1. The Relationship between the Stage Indicators of the Wallas Creative Thinking Process Model with Divergent and Convergent Thinking

No	Stages of the Creative Thinking Process According to Wallas	Activity	Required processes
1	Preparation Stage	The initial process involves understanding the problem and identifying it, which is achieved by directing general knowledge in a more focused direction to obtain the knowledge needed to support problem-solving.	Convergent Thinking
2	Incubation Stage	the activity of combining two different things to produce something new	Divergent Thinking
3	Illumination Stage	the process of uncovering novel ideas	Divergent Thinking
4	Verification Stage	activity of showing the correct solution of the new configuration	Divergent Thinking and Convergent Thinking

Adaptation of Sukmaangara and Madawistama [10]

The processes of divergent and convergent thinking are presented in the context of problem-solving thinking design. The concept of design thinking integrates divergent and convergent thinking patterns to solve problems and formulate effective solutions [11]. The fundamental principles outlined below are the design thought process flow [12]:

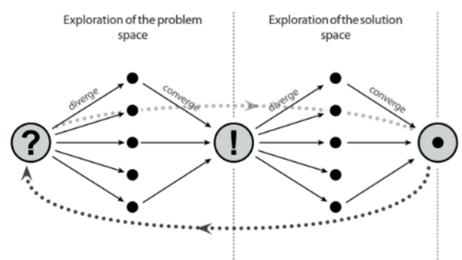

Figure 1. Basic Principles of Design Thinking Flow

Based on Table 1 and Figure 1, it can be concluded that divergent and convergent thinking complement each other in shaping the process of mathematical creative thinking. The preparation and verification stages tend to involve convergent thinking, a method of thinking that focuses on understanding the problem and finding the correct answer. Meanwhile, the incubation and illumination stages utilize more divergent thinking, namely the ability to generate various ideas or possible solutions. This pattern aligns with the basic principles of design thinking, which combine divergent and convergent thinking processes alternately to find and select solutions. Thus, this study will utilize the Wallas stage indicators table and the basic principles of the design thinking flow to analyze divergent and convergent thinking in the mathematical creative thinking process.

Mathematical creative thinking is structured around four essential elements: fluency, flexibility, originality, and elaboration. Fluency indicates the capacity to propose numerous ideas; flexibility shows how students can adapt or change information to develop new solutions; originality highlights the uniqueness of ideas produced; and elaboration involves expanding on those ideas by integrating theoretical insights [13]. Torrancce argues that the process of creative thinking involves four key elements: originality, fluency, flexibility, and elaboration [14]. Munandar stated that creative thinking is measured through four indicators, namely fluency, flexibility, originality, and elaboration [15]. This research focused solely on two specific indicators of creative thinking, namely: (1) Originality, which is characterized by the ability to produce new expressions, think unconventionally, and create unique combinations; (2) Elaboration, which includes the ability to expand ideas and add details to make an idea more interesting [15].

The aspect of originality enables the discovery of new, unique ideas from a given problem and simultaneously combines them into a solution [16]. Originality makes a significant contribution to supporting the creative thinking process [17]. The component of originality is seen as a fundamental element in creativity, which is recognized by many experts [18], [19]. This is something new, but without originality, there is no creativity. Based on the previous description, originality is the ability to create new ideas that are unique and different from the usual. This description highlights the crucial role of originality in fostering the creative thinking process.

Elaboration stands as a significant aspect alongside originality. It involves the ability to refine and extend initial ideas [20], [21], [22]. Elaboration is an indicator of creative thinking that is necessary because creative thinking requires the explanation of new and potentially useful ideas [23]. The generation of original ideas must be complemented by the capacity to elaborate on those ideas in order to realize their creative potential [24]. The aspect of elaboration has long been recognized as an important component to study in research on creativity in the field of education [25]. Thus, elaboration is the skill of explaining, detailing, and developing ideas to aid the problem-solving process. Like originality, elaboration plays a crucial role in the development of creative thinking.

The essential roles of divergent and convergent thinking are closely tied to the functions of the human brain. Structurally, the brain is divided into two major hemispheres: the left and the right, each with distinct cognitive functions. According to Haryanto, the left hemisphere predominantly governs convergent thinking, while the right hemisphere is responsible for divergent thinking [26]. The distinct functions of the brain's hemispheres lead to thinking tendencies, where an individual's cognitive dominance is influenced by the hemisphere that is more active or dominant. Geske explained that brain dominance influences how a person processes information and, in turn, directly affects their learning style [27]. Differences in the function of the left and right brain influence an individual's perspective, thus demonstrating the significant role of both hemispheres in divergent and convergent thinking processes.

From the preceding explanation, it can be inferred that divergent and convergent thinking are essential elements of the creative thinking process in problem-solving, with both being strongly linked to brain function and shaping how individuals process information.

Furthermore, the discussion above also emphasizes the essential role of originality and elaboration in the creative thinking process. This study examines how divergent and convergent thinking, along with indicators of originality and elaboration, manifest within Wallas' stages of creative thinking during problem-solving in the design of the creative thinking process. Wallas' stages are used because they can show how divergent and convergent thinking occur in the creative thinking process [6]. Similar to Wallas' stages, design thinking also demonstrates the interplay of divergent and convergent thinking in its process [11].

Research on creative thinking processes that highlight divergent and convergent thinking aspects is still relatively limited. Several previous studies have attempted to explore both types of thinking, such as Hidayatullah's study, which emphasized the importance of translating divergent and convergent thinking into an operational framework for creativity-oriented music learning [28]. A similar study by Bruce examined the implications and need to integrate divergent thinking into creativity models [29]. Both studies examined the role of divergent and convergent thinking in the context of general creativity development. Meanwhile, in the context of divergent and convergent thinking in the creative thinking process based on brain dominance, Sukmaangara and Madawistama have actually studied this [10]. However, that research focused on fluency and flexibility. Unlike those studies, this study aims to expand the analysis to include originality and elaboration, which have not been previously examined. Thus, this research provides a new contribution to understanding divergent and convergent thinking patterns in the context of mathematical creative thinking based on brain dominance. The purpose of this study is to obtain an overview of divergent and convergent thinking in the process of mathematical creative thinking, with indicators of originality and elaboration reviewed from the perspective of brain dominance. This research is expected to provide an overview of divergent and convergent thinking to help teachers design learning that appropriate to student' brain dominance.

2. METHOD

This study employed a qualitative method using an exploratory descriptive approach. The researcher conducted an in-depth investigation of students' divergent and convergent thinking processes in solving problems related to originality and elaboration. The research continued until sufficient data were collected to meet the study's objectives. The findings were presented in written descriptions.

The research subjects were selected after administering a brain dominance test to 31 students at SMPN 1 Tasikmalaya. The test revealed that 18 students exhibited left-brain dominance, six students had balanced brain dominance, and seven students demonstrated right-brain dominance. From these groups, one student representing each brain dominance category was purposively selected to achieve the study's objectives. The selection of subjects also takes into account students' skills in solving mathematical problems and explaining them orally. To strengthen the credibility and validity of the data, the selected participants underwent the brain dominance test three times, with two subsequent tests administered at different intervals following the initial assessment [30]. Three selected subjects have provided the necessary data, enabling the achievement of the study's objectives. All research

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subject provided informed consent, and their identities were kept confidential to protect privacy and uphold research ethics principles.

Three instruments were employed to gather the research data: the brain dominance test, the mathematical creative thinking test measuring originality and elaboration, and a structured interview. The brain dominance test was taken from a tender dissertation [31]. Meanwhile, this mathematical creative thinking test is a researcher-created instrument that has been validated by three validators. The three validators are experts in mathematics education with doctoral degrees. Validation was conducted in two meetings: the first focused on instrument corrections, while the second validated the revised results from the first meeting. Data analysis followed the Miles and Huberman framework, involving three steps: data reduction, data display, and drawing and verifying conclusions [32].

3. RESULTS AND DISCUSSION

3. 1. Result

Convergent and divergent thinking processes will be analyzed in relation to the design of students' thought processes in solving originality and elaboration problems. The design of students' thought processes is based on the analysis of students' answers to originality and elaboration problems, as well as video recordings and interviews. The following is a description of the flow of students' thought processes in answering creative thinking questions on the originality and elaboration indicators:

1) **Result of Solving Problems of Originality and Elaboration of Left-Brain-Dominant Students**

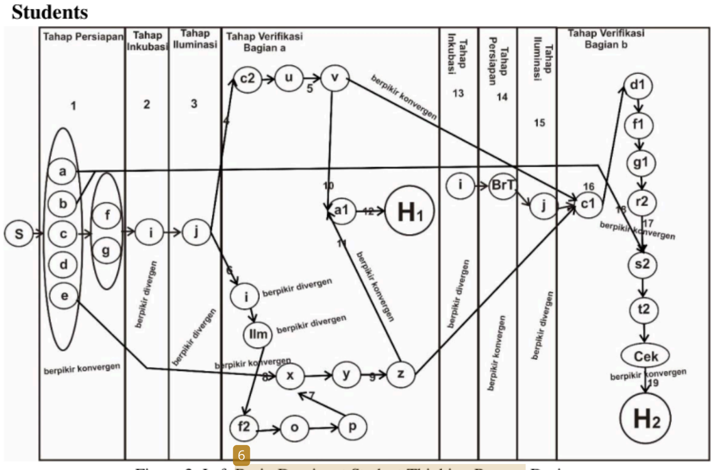

Figure 2. Left Brain Dominant Student Thinking Process Design

The description of the code used in the design image of the thinking process of students with left-brain dominance can be seen below:

Table 2. Description of the Design Code for Left-Brain-Dominant Students' Thinking Process

Code	Description	Code	Description
S	Question	x	$V_{air+batu} = +V_{air} V_{batu}$
a	$p_{akuarium} = = 80$ cm p_{air}	y	$V_{air+batu} = 96{,}000$ cm^3 + 26,400 cm^3
b	$l_{akuarium} = = 30$ cm l_{air}	z	$V_{air+batu} = 122{,}400$ cm^3
c	$t_{akuarium} = 50$ cm	a1	$V_{air+batu} > V_{akuarium}$
d	$t_{air} = 40$ cm	H1	Spilled Water
e	$V_{batu} = 26{,}400$ cm^3	BrT	Ask
f	Is the water spilling? Why?	c1	$V_{air\ tumpah} = 122{,}400$ cm^3 – 120,000 cm^3
g	How high is the water after the stone is removed?	d1	$V_{air\ tumpah} = 2{,}400$ cm^3
i	Looking for ideas	f1	$V_{air\ setelah\ diambil\ batu} = 96{,}000$ cm^3 – 2,400 cm^3
j	Get an idea	g1	$V_{air\ setelah\ diambil\ batu} = 93{,}600$ cm^3
c2	$V_{akuarium} =$ Area of the Base x$t_{akuarium}$	r2	Volume of block = pxlxt_{air}
u	$V_{akuarium} =$ 80 cm x 30 cm x 50 cm	s2	93,600 cm^3 = 80 cm x 30 cm xt_{air}
v	$V_{akuarium} = 120{,}000$ cm^3	t2	93,600 cm^3 = 2,400 cm^3 x t_{air}
f2	$V_{air} =$ pxlxt	Check	Double-check the answers
o	$V_{air} =$ 80 cm x 30 cm x 40 cm	H2	Height of water change in aquarium ()= 39 cm3t_{air}
p	$V_{air} = 96{,}000$ cm^3	1-19	Sequence of Problem-Solving Flow
Film	Get an idea or concept		

Based on Figure 2 and Table 2, students begin solving problems with the preparation stage. Students read, recall lessons learned, and write down what they have learned from the problems they have already understood (codes a–g). Students undergo an incubation stage by taking the time to reflect, which enables them to generate ideas (code i). It does not take long for students to complete the illumination stage. Students receive ideas for solving part A (code J). The following interview results support the activities that have been carried out:

P : What were your initial steps in solving problem number 2?

S : I reread the problem to understand the information presented in the problem and memorize the material until I found a solution.

The verification stage begins with the student using the prism formula to solve part a by calculating the aquarium's volume. The student determines the volume of the aquarium by applying the prism formula, substituting the given dimensions: 80 cm for length, 30 cm for width, and 50 cm for height, to obtain a result of 120,000 cm³ (code c2 - v). Before performing the calculation of the aquarium's volume, students demonstrate signs of entering an incubation stage of thinking (code i). Students spend about one minute reading the questions to find ideas. Students get ideas to continue (Ilm code). This activity is the illumination stage. Divergent thinking is necessary to complete the illumination stage activities [6]. Next, the student calculates the volume of water in the aquarium using the formula for a rectangular prism. By substituting 80 cm, 30 cm, and 40 cm for the length, width, and water height, respectively, they find the volume to be 96,000 cm^3 (code f2 – p).

The student then continued by analyzing the relationship between the volume of water and the volume of rock. The student determines the total volume by summing the volume of the water and the volume of the rock, resulting in 122,400 cm³ (code x – z). Students find the relationship between the volume of the aquarium and the sum of the volumes of water and rock. The student determines that the water will spill since the

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aquarium cannot hold the total volume of water plus rock (code a1 – H1). The activity carried out is reinforced by the results of the students' answers in part a as follows:

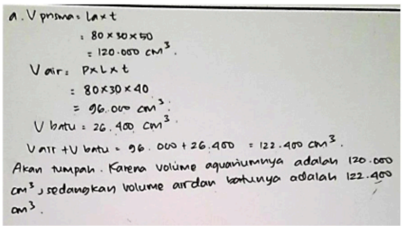

Figure 3. Solution to Question Number 2 Part a by S23

The student reviewed the content of part B to clarify the information needed to answer the questions, and the time it took the student to answer the questions in part B appeared to be longer than the time it took to answer the previous questions. This stage involves a series of incubation stages aimed at generating ideas (code i). While completing this step, the student was still confused about how to write the reason. After some time, the student became convinced that a change had occurred due to the spilled water from the aquarium. This suspicion grew stronger based on the following questions the student asked the researcher (Code BrT).

Students review the questions by considering the previous answers in part a and rereading the same questions. A few moments later, they come up with an idea for solving part b (code j). The volume of spilled water was calculated as 2,400 cm^3, obtained by subtracting the total volume occupied by water and rocks from the aquarium's full capacity (code c1 – d1). The next step is to calculate the amount of water left in the aquarium after it spills, which is achieved by subtracting the original volume of water from the volume of water that spills, resulting in 93,600 cm^3 (code f1 – g1). The water level after the stone's removal is calculated by the student using the formula for the volume of a rectangular prism (also known as a cuboid). The values of length 80 cm, width 30 cm, and water volume 93,600 cm^3 are entered into the formula V = *p* x *l* x *t*, forming the equation 93,600 = 80 × 30 × t (code r2 – t2). Students connect the volume of water remaining after the spill to the known dimensions of the aquarium's length and width. The student initially calculated the answer incorrectly but then double-checked it and discovered the error. This checking was repeated several times (code Check). The student obtained the correct result, which is that the water level in the aquarium after the spill is 39 cm (Code H2). This is consistent with the student's answer in the following image:

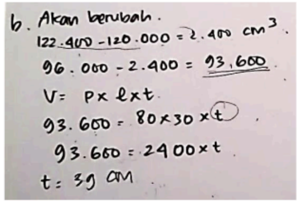

Figure 4. Solution to Question Number 2 Part b

2) Result of Solving Problems of Originality and Elaboration of Balanced Brain Dominant Students

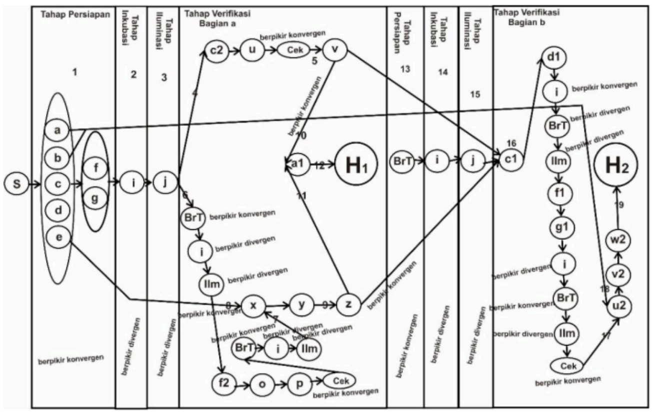

Figure 5. A Balanced Brain dominates the Thinking Process of Students

The description of the code used in the design image of the thinking process of students with a balanced brain can be seen below:

Table 3. Description of the Design Code for the Thinking Process of Students with a Balanced Brain Dominance

Code	Description	Code	Description
u2	tair = pairx lair : 93,600 cm^3	w2	tair = 2,400 cm^2: 93,600 cm^3
v2	floor = 80 cm x 30 cm: 93,600 cm^3		

Based on Figure 5 and Table 3, students begin the preparation stage by carefully reading the questions, recalling previously taught material, and then writing down their understanding of the questions (codes a–g). Activities in the preparation stage involve understanding the problem and identifying it by directing general knowledge in a more focused direction to obtain the knowledge needed to support problem-solving. The next stage is the incubation stage (code i). The student appeared to reread the questions written on their answer sheets, paused for a moment, and then immediately wrote down the answers for part

A. This behavior describes the process of idea emergence in students, which occurs at the illumination stage (code J).

Students begin the verification stage by applying the prism volume formula to the aquarium's dimensions. Student substitute 50 cm (length), 30 cm (width), and 80 cm (height) to obtain a volume of 120,000 cm^3 (code c2 - v). The student demonstrated an effort to re-understand the problem through questions posed to the researcher.

The student conceived the idea after a lengthy discussion with the researcher. To find the volume of water in the aquarium, students apply the formula for the volume of a cuboid (V = p × l × t) and substitute the given dimensions: length 80 cm, width 30 cm, and height 40 cm, so that the final result is 96,000 cm^3 (code f2 – p). To obtain further information, the student held further discussions with researchers.

After holding discussions, the student promptly calculated the combined volume of water and the stone, resulting in a total volume of 122,400 cm^3 after the stone was placed in the aquarium (code – z). Students analyze the situation by comparing the aquarium's volume with the total volume of water and the rock. The student concluded that this condition would cause the water to spill. The student argued that the spill occurred because the volume of the rocks inserted caused the total volume to exceed the volume of the aquarium (code a1 – H1). Evidence of this activity is seen in the students' answers in part a, as shown below:

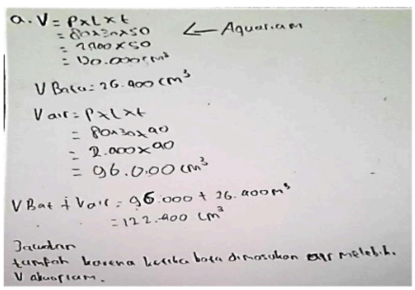

Figure 6. Answer to Solve Question Number 2 Part a

The following step students take is to work on part b. In the process, students dig for further information by asking a number of questions to the researcher:

Students consider strategies for solving part b for a relatively long time. This stage is the incubation stage. A few moments later, students enter the illumination stage by finding ideas and starting to work on the problem again. The next step is for the student to carry out the verification stage. The student applies logical reasoning by calculating the difference between the aquarium's volume and the sum of the water plus rock volumes, resulting in 2,400 cm^3 of overflow (code c1 – d1). The student stops briefly (code i) and discusses (BrT); the student successfully gets an idea that helps them continue solving the problem (Ilm). This activity guides the student into a calculation process, where the initial water volume of 96,000 cm^3 is reduced by the spilled volume of 2,400 cm^3, resulting in a remaining water volume of 93,600 cm^3 (code f1 – g1). This result represents the volume of water after the stones have been removed from the aquarium. The student stops briefly (code i) and discusses (BrT); the student then succeeds in generating ideas that help them continue solving the problem (Ilm) before resuming. Before writing the solution to part b of the problem, the student first carries out calculations by dividing the value of 93,600 cm³ by the length and width of the water. This step was taken to confirm whether the applied method was suitable (code Check). The student successfully obtained a water level of 39 cm after removing the stone, despite a slight error in the division process. They began recording their calculations after confirming their results were correct. The student stated that to determine the water level, the volume of water of 93,600 cm^3 is divided by the result of multiplying the length and width, so that the water level after the stone is lifted is 39cm (code u2 – w2). The process of solving part b of the problem can be seen in the following image:

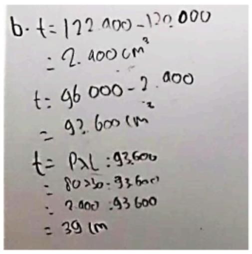

Figure 7. Answer to Solve Question Number 2 Part b

In the process, students experience the incubation stage (code i), namely by exploring various possible ideas to formulate a new method, and then continuing with the illumination stage (code Ilm) when new understanding or ideas emerge.

3) Result of Solving Problems of Originality and Elaboration of Right-Brain-Dominant Students

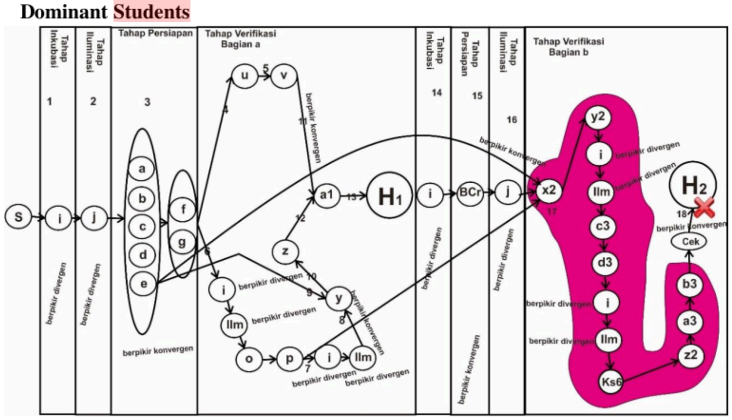

Figure 8. Students' Thinking Processes Are Right-Brain Dominant

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The description of the code used in the design image of the right-brain-dominant student's thinking process is presented in Table 4 below. Based on Figure 8 and Table 4, students begin working on the problem by first completing the incubation stage (code i). This stage is carried out to seek information obtained from the problem and reflect on it to generate ideas. This incubation stage lasts until students get the idea to start solving the problem. Students carry out the illumination stage by generating ideas (code j). The preparation stage begins after the idea is developed. Students read, re-access the knowledge they already have, and note down the information they understand from the questions (codes a–g). Activities in the preparation stage include understanding the questions and identifying problems by directing general knowledge in a more focused direction to obtain the knowledge needed to solve the questions.

Table 4. Description of the Design Code for the Thinking Process of Students with Right-Brain Dominance

Code	Description	Code	Description
BCr	Try different methods to solve the problem	Ks2	there is, reduced to 69,600 cm^3
x2	$V_{air\ setelah\ diambil\ batu}$ = 96,000 cm^3 – 26,400 cm^3	z2	80 cm x 60 cm x x = 69,600 cm3
y2	$V_{air\ setelah\ diambil\ batu}$= 69,600 cm^3	a3	2,400 cm^2 x x = 69,600 cm^3.
c3	$V_{air\ setelah\ diambil\ batu}$ = 120,000 cm^3 – 26,400 cm^3	b3	x = 29 cm
d3	$V_{air\ setelah\ diambil\ batu}$= 93,600$cm^3$		Stage Errors in Solving Problems

The verification stage was carried out shortly after the preparation stage was completed. The student applied the cuboid volume formula (V = p × l × t), substituting 80cm, 30cm, and 50cm for length, width, and height, respectively, and obtained a volume of 120,000 cm^3 (code u – v). The student took a moment to reflect before performing the calculation of the aquarium's water volume (code i). After a brief pause, an idea emerged in the student's mind as a result of reflective thinking (code Ilm). The student begins the calculation process by multiplying the length, width, and height of the water in the aquarium, namely 80 cm, 30 cm, and 40 cm, which results in a water volume of the aquarium of 96,000 cm^3 (code o – p). Students return to the same steps as before, namely reflecting for a moment and reviewing the available information in the problem before calculating the volume of water after the stone is placed in the aquarium (code i). After thinking for a moment, the student finally came up with an idea that could be used to solve the problem (code Ilm). The total volume after inserting the stones into the aquarium is determined by summing the initial water volume (96,000 cm^3) and the volume of the stones (26,400 cm^3), resulting in a combined volume of 122,400 cm^3 (code y – z). The student attempts to comprehend the correlation between the aquarium's volume and the combined volume occupied by water and rocks. Based on the volume comparison, the student determines that the overflow occurs because the total volume of water and rocks exceeds the aquarium's volume (code a1 – H1). Evidence of this activity is seen in the students' answers in part a, as shown below:

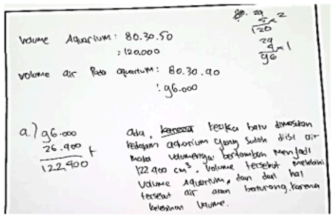

Figure 9. Answers in Solving Question Number 2 Part a

The student initiates the completion of part B by carefully examining the questions to ensure a clear understanding. This stage is the incubation stage (code i). During this incubation stage, students take a relatively long time to continue working on part b. The student continued working on the questions after the researcher initiated a discussion (code BCr).

Students begin the preparation stage by considering various problem-solving strategies before performing calculations. Students engage in discussion activities (code BCr) to identify problems that require convergent thinking [6]. Soon after, the student discovered a new idea that marked their entry into the illumination stage (code j) and began working on the problem again.

The student begins by calculating the volume of spilled water by subtracting the rock's volume from the water's initial volume (96,000 cm^3 – 26,400 cm^3), resulting in 69,600 cm^3 (code $x^2 - y^2$). This approach yields an incorrect conclusion in part B, primarily due to the erroneous assumption that the volume displaced is equivalent to the volume of the extracted rock. However, the steps used are the correct steps to solve part b. If a student can correctly identify the spilled water, then it can be proven that the student can solve both parts a and part b.

Students first go through the incubation stage (code i) to generate ideas, which is then followed by the illumination stage (code Ilm) when the idea is identified, and they proceed to solve the problem. Based on the calculation results, the student concluded that the volume of water decreased due to the spill, namely to 69,600 cm^3 (code Ks2). Student continues the solution process by calculating the height of the water after it spills using the equation 80 cm × 30 cm × x = 69,600 cm^3 (code z2). The calculation is continued by dividing 69,600 cm^3 by 2,400 cm^2, which then produces a value of x equal to 29 cm as the new water level (code a3 - b3). Evidence of this activity is seen in the students' answers in part b, as shown below:

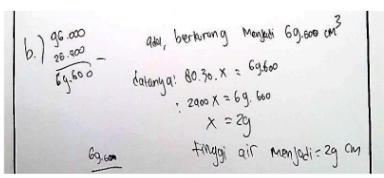

Figure 10. Answer in Solving Question Number 2 Part b

During the verification process, students demonstrated engagement in two forms of thinking processes. First, through the answer checking stage (code Check), the student applied convergent thinking processes to ensure the correctness of the solution [6]. Second, students also engaged in the incubation (code i) and illumination (code Ilm) stages, both of which reflect divergent thinking processes [6]. The combination of these two types of thinking demonstrates how the problem-solving process requires not only logical accuracy but also flexibility in thinking.

3. 2. Discussion

1) Analysis of Convergent and Divergent Thinking Processes in Left-Brain-Dominant Students in Solving Originality and Elaboration Problems

The results of the analysis of students with left-brain dominance indicate that the problem-solving process is carried out systematically by following Wallas' stages. Activities in the preparation stage involve understanding the problem and identifying it by directing general knowledge in a more focused direction to obtain the knowledge needed to support problem-solving. Convergent thinking processes are required in these activities [6]. This indicates that left-brain dominant students tend to rely on structured reasoning at the outset of the problem-solving process. Furthermore, students spend about one minute reading the questions to find ideas. The activity of the process of generating ideas is intended to produce new ideas; therefore, a divergent thinking process is required [6]. This finding illustrates that even students with left-brain dominance, who tend to be more analytical, still engage in divergent thinking when attempting to generate new strategies.

Activities in the illumination stage involve discovering something new. This activity requires a divergent thinking process [6]. The presence of divergent thinking in the illumination stage highlights the flexibility of left-brain-dominant students, enabling them not only to rely on rigid logic but also to explore new ideas when facing complex problems. At the verification stage, the student then continues by analyzing the relationship between the volume of water and the volume of rock. Connecting the volume of water and rock is a process of unifying different aspects. This process of unifying different aspects is a process of convergent thinking [12]. Similarly, students find the relationship between the volume of the aquarium and the sum of the volume of water and the volume of the rock. This process of unifying different aspects is a process of convergent thinking [12]. These findings strengthen the understanding that left-brain dominant students maximize their convergent thinking when it comes to integrating quantitative relationships to confirm correctness.

The activity of the process of generating ideas is intended to produce new ideas; therefore, a divergent thinking process is required [6]. This condition is also supported when students use questions to examine problems that involve convergent thinking processes [6]. This demonstrates that left-brain dominant students combine both divergent and convergent thinking dynamically, depending on the stage of problem-solving. Additionally, students relate the volume of water remaining after the spill to the known dimensions of the aquarium's length and width. This activity combines different aspects that require convergent thinking processes [12]. When students engage in answer-checking activities that require convergent thinking processes [6], it indicates their tendency to carefully validate results before concluding.

Based on the analysis, left-brain dominant students tend to exhibit a relatively higher use of convergent thinking compared to divergent thinking. This is demonstrated by their systematic approach in examining relationships between water volume, rock volume, and aquarium capacity, as well as through repeated verification steps. Nevertheless, the use of convergent thinking does not entirely overshadow divergent thinking, which continues to emerge in moments of idea exploration and discovery. Research by Sukmaangara and Madawistama also found that students with a dominant left brain were more dominant in convergent thinking [10]. This is also in line with what Haryanto and then Munawaroh and Haryanto stated, who stated that the left hemisphere tends towards convergent thinking [33], [34].

2) Analysis of Convergent and Divergent Thinking Processes in Balanced Brain Dominant Students in Solving Originality and Elaboration Problems

The results of the analysis show that students with balanced brain dominance demonstrate the ability to utilize both convergent and divergent thinking in proportion to each other in the process of mathematical creative thinking. Activities in the preparation stage involve understanding the problem and identifying it by directing general knowledge in a more focused direction to obtain the knowledge needed to support problem-solving. Convergent thinking processes are required in these activities [6]. At the incubation and illumination stages, students pause and then generate ideas to continue the problem-solving process. The activity of searching for and finding ideas is intended to generate new ideas, a divergent thinking process is required [6].

In solving part a, the student analyzes the situation by comparing the aquarium's volume with the total volume of water and the rock. This activity combines different aspects that require convergent thinking processes [12]. Through this comparison, students conclude that water will spill because the combined volume exceeds the aquarium's capacity. In working on part b, students carry out questioning activities (code BrT) to identify problems that require convergent thinking processes [6]. This indicates that students with balanced brain dominance are more likely to clarify and test their understanding before proceeding with problem-solving steps.

Furthermore, the activity of finding and generating ideas is an activity that requires divergent thinking [6]. This was reflected when students paused during the incubation stage and subsequently experienced illumination by producing new ideas that guided them to continue solving the problem. During the verification stage, students actively ask questions (code BrT) as an effort to identify problems that require convergent thinking processes [6]. The activity necessitates a divergent thinking process [6]. Furthermore, the student activity of checking the answer (Cek Code) involves convergent thinking processes [6].

Overall, the findings illustrate that students with balanced brain dominance are capable of integrating divergent and convergent thinking equally. This balance enables them to employ convergent thinking to structure and validate solutions while simultaneously utilizing divergent thinking to explore and generate new ideas during problem-solving.

Research by Sukmaangara and Madawistama also found that students with balanced brain dominance have balance in convergent and divergent thinking [10].

3) Analysis of Convergent and Divergent Thinking Processes in Right-Brain-Dominant Students in Solving Originality and Elaboration Problems

The analysis of problem-solving processes in right-brain dominant students reveals that their thinking is strongly characterized by the use of divergent thinking, particularly during the incubation and illumination stages. At the beginning of the process, students enter the incubation stage, where they reflect on the problem until an idea emerges. This is followed by the illumination stage, where students generate new ideas to solve the task. The activity of finding and generating ideas is an activity that requires divergent thinking [6]. Likewise, activities at the illumination stage are a process of discovering new things, which requires the use of divergent thinking [6]. These findings indicate that students with right-brain dominance approach the early stages of problem-solving through creativity and idea exploration.

After obtaining initial ideas, students proceed to the preparation stage, which focuses on structuring knowledge and identifying problems. At this point, students reread the questions, recall prior knowledge, and record information relevant to the problem. Activities in the preparation stage include understanding the questions and identifying problems by directing general knowledge in a more focused direction to obtain the knowledge needed to solve the questions. This activity requires convergent thinking [6]. When applying the cuboid volume formula to calculate the aquarium's capacity, students demonstrate their ability to work systematically and logically. The student attempts to comprehend the correlation between the aquarium's volume and the combined volume occupied by water and rocks. This activity combines different aspects that require convergent thinking processes [12]. These convergent-oriented activities highlight how right-brain dominant students balance their divergent ideation with logical analysis.

In completing part B, students initially revisit the incubation stage, taking longer pauses to reflect and search for new ideas before proceeding. Researcher enriches the process through student discussions, which further guide problem identification. Students engage in discussion activities (code BCr) to identify problems that require convergent thinking [6]. Shortly after, students re-enter the illumination stage and develop new strategies for problem-solving. The activity of finding and generating ideas is an activity that requires divergent thinking [6]. Likewise, activities at the illumination stage are a process of discovering new things, which requires the use of divergent thinking [6]. Although the calculation of the spilled water volume (96,000 cm^3 – 26,400 cm^3 = 69,600 cm^3) resulted in an incorrect interpretation of volume displacement, the procedural steps taken were consistent with the correct method, indicating a strong attempt to integrate both creativity and structure in the problem-solving process.

The final stages of verification demonstrate how right-brain dominant students combine flexibility with logical accuracy. During this process, they confirmed the results and continued their calculations to determine the water level after the spillage, arriving at a new height of 29 cm. First, through the answer checking stage (code Check), the student applied convergent thinking processes to ensure the correctness of the solution [6]. Second, students also engaged in the incubation (code i) and illumination (code Ilm) stages, both of which reflect divergent thinking processes [6]. This dual engagement highlights that their problem-solving is not limited to either creative exploration or logical verification, but instead emerges as a dynamic interplay between the two. Thus, right-brain dominant students tend to employ divergent thinking while still relying on convergent processes to refine and validate their solutions. Research by Sukmaangara and Madawistama also found that students with a dominant left brain were more dominant in divergent thinking [10]. This is also in line with what Haryanto and then Munawaroh and Haryanto stated, who stated that the left hemisphere tends towards divergent thinking [33], [34].

4. CONCLUSION

Based on the analysis of Figures 3, 6, and 9, as well as the interview results, it can be concluded that the tendency of students' creative thinking processes in solving originality and elaboration problems corresponds to brain dominance. Students with left-brain dominance tend to be more prominent in convergent thinking. Conversely, students with right-brain dominance tend to be more adept at using divergent thinking. Meanwhile, students with balanced brain dominance exhibit a relatively balanced ability to use both types of thinking, including convergent and divergent thinking.

The results of this study offer valuable insights for educators in constructing problem sets that stimulate such thinking processes, while considering students' brain dominance to maximize learning achievements. Based on these results, teachers should design learning experiences that balance convergent and divergent thinking through a variety of task types, paying attention to students' brain dominance, and implementing a creative, stage-based approach (Wallas). This approach allows each student to optimally develop their creative thinking potential in solving mathematical problems, thereby training balanced thinking in all students. Teachers can also design structured, single-answer-oriented tasks to train students in convergent thinking, as well as open-ended tasks that allow for multiple solutions to train students in divergent thinking.

This study has several limitations. The very small number of participants from a single school limits the generalizability of the results. Furthermore, the qualitative approach used provides an in-depth understanding of students' thinking processes, but is insufficient to describe general patterns. Nevertheless, this study extends the literature by linking brain dominance to the balance of convergent and divergent thinking in mathematical problem solving and provides a practical contribution to the development of instructional design. This aspect is also rarely researched in depth. For future research, it is recommended to use a quantitative approach with a larger sample size and more diverse school contexts. Furthermore, research on brain dominance can be expanded beyond creative thinking to other types of thinking processes, such as critical, analytical, reflective, and algebraic thinking, to provide a deeper understanding of cognitive functions in mathematics learning.

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