



Analysis of Thinking Process Strategies in Providing Scaffolding Questions Based on Design Thinking in Elementary School Mathematics Learning

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ABSTRACT

Student competence in mathematics learning varies greatly and requires teacher assistance to achieve the next level of competence. Teacher assistance, known as scaffolding, enables students to break down problems, explore various possible solutions, and ultimately make decisions based on a strong understanding and existing evidence. These questions help students to focus, think logically, and develop the ability to analyze and synthesize information. This study employs a teacher thinking process scaffolding strategy, which has not been previously researched in mathematics learning, utilizing a Design Thinking approach. This study aims to produce a theory of dominant contingent teacher thinking process strategies in providing design thinking-based scaffolding in mathematics learning. This study uses a qualitative approach (grounded theory design) conducted in the context of mathematics learning. The research subjects are two types of elementary school mathematics teachers, each with dominant contingent analytical (GA) and dominant contingent intuitive (GI) characteristics when providing scaffolding. The selection of material and both subjects was based on the results of long-term observations conducted by researchers on the teaching practices of 30 elementary school mathematics teachers in the city of Malang. The researcher recorded the subjects' teaching using video. Teachers with analytical contingencies tended to focus more on logic and structured procedures, using carefully designed questions to help students think systematically. Teachers with intuitive contingencies more often asked questions that opened up space for exploration, encouraging students to think creatively and connect the concepts they had learned.

Keywords: *Thinking Process Strategies; Question; Scaffolding; Design Thinking*

ABSTRAK

Kompetensi siswa dalam pembelajaran matematika sangat beragam dan membutuhkan bantuan guru untuk dapat mencapai kompetensi selanjutnya. Bantuan guru atau dikenal dengan scaffolding memungkinkan siswa untuk menguraikan masalah, mengeksplorasi berbagai kemungkinan solusi, dan akhirnya membuat keputusan yang didasarkan pada pemahaman kuat dan bukti yang ada. Pertanyaan tersebut membantu siswa untuk fokus, berpikir secara logis, dan mengembangkan kemampuan menganalisis dan mensintesis informasi. Dalam penelitian ini menggunakan strategi scaffolding proses berfikir guru yang selama ini belum pernah diteliti pada pembelajaran matematika yang bermuatan pendekatan Design Thinking. Penelitian ini bertujuan untuk menghasilkan teori strategi proses berfikir guru yang dominan kontingen dalam menyediakan scaffolding bermuatan design thinking pada pembelajaran matematika. Penelitian ini menggunakan pendekatan kualitatif

(grounded theory design) yang dilakukan dalam konteks pembelajaran matematika. Subjek penelitian yaitu 2 tipe guru matematika sekolah dasar, masing-masing memiliki karakteristik dominan kontingen analitis (GA) dan dominan kontingen intuitif (GI) ketika menyediakan scaffolding. Pemilihan materi dan kedua subjek tersebut berdasarkan hasil observasi jangka panjang yang dilakukan oleh peneliti terhadap pembelajaran yang dilaksanakan oleh 30 guru matematika sekolah dasar di kota Malang. Peneliti merekam pembelajaran yang dilakukan subjek menggunakan video. Guru dengan kontingensi analitis cenderung lebih berfokus pada logika dan prosedur yang terstruktur, menggunakan pertanyaan yang didesain dengan cermat untuk membantu peserta didik berpikir secara sistematis. Guru dengan kontingensi intuitif lebih sering memberikan pertanyaan yang membuka ruang untuk eksplorasi, mendorong peserta didik untuk berpikir kreatif dan menghubungkan konsep-konsep yang telah dipelajari.

Kata Kunci: Strategi proses berpikir, pertanyaan, scaffolding, design thinking

INTRODUCTION

In mathematics learning, mathematical thinking is thinking about mathematical processes (Muhammad Khalil, 2023; Tonra et al., 2023). Mathematical thinking is important for solving mathematical problems and learning mathematics, but also for teaching mathematics, such as problem-solving, representation, reasoning, and communication (Mazlini Adnan, 2024; Muhammad Khalil, 2023). A teacher must think mathematically to analyze subject matter, plan lesson objectives, and anticipate student responses. In addition, teachers also need to provide opportunities for students to develop thinking skills (NCTM, 2000; Srikongpan et al., 2024). Therefore, good mathematics learning requires teachers to think.

Teachers' thought processes are critical in facilitating mathematics learning by influencing how learners learn and assess mathematical processes such as representation, reasoning, and evidence, which ultimately impact students' understanding and development. One of the teacher's thought processes can be seen in providing Scaffolding or assistance in the form of questions to help students solve mathematical problems (Yayuk et al., 2024).

Teachers' conceptual and pedagogical knowledge is essential in providing Scaffolding (Kamrani et al., 2024). Teachers with good conceptual and pedagogical knowledge will guide learners toward deep understanding. Of course, it differs from teachers with poor conceptual and pedagogical knowledge because these teachers will have difficulty helping their learners.

In general, research results show that Scaffolding is an effective learning strategy (Arora et al., 2024; Hammasa et al., 2024; Haryati et al., 2024; Mindigulova et al., 2024; Zuo et al., 2023). However, none of these studies specifically discuss Scaffolding in mathematics education. Research on Scaffolding is more studied in the field of literacy, but there is still a minor in mathematics. Therefore, researchers feel it is important to examine the provision of Scaffolding in mathematics learning.

Future research challenges need to be analyzed in Scaffolding because it is new in current educational research (Lawrence, 2024). The analysis examines fragments of learning interactions between teachers and students when teachers provide Scaffolding. The correspondence between the teacher's provision of Scaffolding and students' understanding in an interaction fragment is known as contingency. Contingency is a requirement for Scaffolding and is the main characteristic of Scaffolding. Furthermore, a teacher is said to act contingently when the teacher adjusts his/her assistance to the student's level of understanding.

Question scaffolding provides direct questions that help learners gradually build mathematical concepts, solve problems, and improve critical thinking skills (Faheem Khan et

al., 2022; Fani et al., 2023). In design thinking, learners are encouraged to understand the problem thoroughly, ideate creative solutions, and prototype and evaluate results. Question scaffolding is a support tool that allows learners to explore each stage of design thinking, from understanding to evaluation, by directing learners to find relevant solutions independently. This approach makes mathematics learning more meaningful and contextual and involves higher-order thinking skills.

METHODS

Type and Design

This study aims to obtain information related to thinking process strategies in providing design thinking-based scaffolding questions in elementary school mathematics learning. This study uses a qualitative approach (grounded theory design) conducted in the context of mathematics learning. The research subjects were two elementary school mathematics teachers, each of whom had dominant contingent analytical (GA) and dominant contingent intuitive (GI) characteristics when providing scaffolding. Teachers with dominant contingent analytical characteristics tend to rely on logical thinking, data, and systematic analysis in the teaching process. Teachers with these characteristics usually follow structured teaching methods, use evidence and data to support decisions, and focus more on rational problem solving. Meanwhile, teachers with dominant intuitive contingencies rely on instinct, feelings, and experience in their teaching. Intuitive teachers tend to be more flexible, often relying on intuition to understand student needs and spontaneously adjusting teaching strategies. The selection of material and both subjects was based on long-term observations conducted by researchers on the teaching practices of 30 elementary school mathematics teachers in the city of Malang.

The following are indicators for research instruments that will be used in theoretical and practical studies on exploring thinking process strategies in providing design thinking-based scaffolding questions in elementary school mathematics learning:

- a. Indicators of the thinking process in providing question scaffolding include problem identification, empathy, ideation, and prototyping.
- b. Question scaffolding quality indicators include question clarity; level of difficulty; contextual relevance; interactive approach; and encouraging reflection.
- c. Indicators of learning success with design thinking include: understanding of mathematical concepts; problem-solving skills; creativity and innovation; collaboration and communication; and reflection and iteration.

Data and Data Sources

This research, carried out in several systematic stages, can be explained as follows:

1. Phase I (Conducting Research Concept Design),

This stage began with holding a forum group discussion (FGD) with the research team to gain insight into the research needs. The results of the FGD were compiled using a research concept design. The implementation of this stage includes a literature review, an analysis of previous research, and a problem analysis. Literature study helps examine the main concepts such as question scaffolding, design thinking, and mathematics learning in elementary school.

2. Phase II (Developing Research Instruments),
At this stage, researchers compiled research instruments using the data collection techniques used, namely observation, interviews, and documentation. This stage also conducted a literature study to find similar previous research instruments so that they could be used as references. Compiling research instruments is done by designing questions based on indicators that have been explicitly determined. Questions are arranged systematically in a logical order and are easy for respondents to follow.
3. Phase III (Data Collection)
At this stage, researchers collect data by carrying out activities in the field using the research instruments that have been prepared. Data was collected through observation, interviews, and documentation of teachers with dominant analytical contingents and teachers with dominant intuitive contingents.
4. Phase IV (Data Analysis)
Analyzing data from all information obtained using a qualitative data analysis approach. According to Creswell (21), the research team conducted information organization and data management activities, including 1) data collection, 2) data reduction, 3) data presentation, and 4) conclusion drawing related to the strategy, impact, and constraints of the teacher's thinking process in providing scaffolding questions with design thinking content in mathematics learning in elementary schools.
5. Phase V (Data Interpretation)
The researcher will examine the quantitative and qualitative data obtained through various instruments, such as observations, interviews, and documentation. The researcher will also compare these findings with the existing literature to assess the congruence or differences with previous studies. In addition, the researcher will interpret the data in the context of mathematics learning in primary schools, highlighting how the design thinking approach can improve students' understanding of mathematical concepts and problem-solving skills.

RESULTS AND DISCUSSION

1) Teachers' thought process strategies in scaffolding design thinking questions in primary school mathematics learning

The research was conducted from September to December 2024 in the odd semester of the 2024/2025 school year in Mathematics. The research subjects were two groups of elementary school teachers in Malang Raya who have dominant characteristics of analytical contingents, namely data-based approaches, and dominant intuitive contingents, namely approaches based on experience and instinct.

Based on the observations made by researchers on Mathematics learning in elementary schools, the analysis of the differences and characteristics of each group was obtained. The following is an analysis of the differences in characteristics between teachers with analytical contingency and teachers with intuitive contingency when providing question *scaffolding* in mathematics learning.

Table 3.1 Analysis of the characteristics of the differences between the two groups of teachers

Aspects	Teacher with Analytical Contingency	Teacher with Intuitive Contingency
Approach to Questioning	Using carefully planned questions, focusing on analysis and logical reasoning.	Use more spontaneous questions and adapt to learners' responses.
Question Focus	Focus more on systematic procedures and steps in problem-solving.	More focus on understanding concepts and relationships between ideas in mathematics.
Question Type	Questions are more structured and sequential, covering systematic steps to arrive at an answer.	Questions are more open-ended and allow learners to explore different solutions or strategies.
Key Objectives	To direct learners to a straightforward thinking process with structured steps.	To facilitate concept discovery through free thinking and learner reflection.
Interaction with Learners	The teacher directs with direct instruction, providing more measured and targeted feedback.	Teachers are more responsive to learners' initiatives, providing space for discussion and Exploration.
Examples of Teacher Behavior	"Can you explain the first step you took? Then, what is the next step?"	"How can you relate this idea to the concepts we discussed earlier?"
Speed of Decision Making	It is slower and more planned, based on analyzing learners' needs.	Faster and more flexible, often relying on intuition and the moment's circumstances.
Reflection on Learner Error	Direct learners to carefully analyze their own mistakes and find solutions.	Motivate learners to understand mistakes as part of the learning process and encourage learners to find new ways to solve them.
Scaffolding	Provide structured Scaffolding, leading to the achievement of specific learning objectives.	Provide freer Scaffolding, allowing learners to explore and learn from conversations.

In this way, the two approaches contribute differently to the mathematics learning process. The analytical contingency teacher focuses more on procedural mastery, while the intuitive contingency teacher emphasizes conceptual understanding and exploring new ideas. *Scaffolding* and *the design thinking* approach have a close relationship in elementary school learning mathematics because both support learners' critical and creative thinking processes through a structured yet flexible approach. *Scaffolding* in mathematics learning serves to provide temporary assistance to learners, allowing learners to understand complex mathematical concepts gradually by solving problems into parts that are easier to understand.

In this case, design thinking questions play an important role by guiding learners to look at problems from various perspectives, formulate creative solutions, and explore alternatives. *Design thinking*, which emphasizes empathy, problem definition, ideation, prototyping, and testing, provides space for learners to explore the potential of learners' ideas in solving mathematical problems. This combination of *Scaffolding* and *design thinking* allows learners to understand mathematical procedures and develop critical and innovative thinking abilities that are important in long-term learning, equipping learners with the skills to solve real-life problems in a more structured and creative way.

Based on the research results, the analysis of scaffolding questions with a design thinking approach to learning Mathematics in Elementary Schools is obtained.

Table 3.2 Analysis of question scaffolding with design thinking approach

Indicator	Teacher with Analytical Contingency	Teacher with Intuitive Contingency
<i>Scaffolding</i> Provision Planning	Teachers design <i>Scaffolding</i> based on an objective analysis of the material, learning objectives, and learners' needs.	Teachers rely on experience and an instinctive understanding of the learner's context when designing <i>Scaffolding</i> .
Formulation of <i>Design Thinking</i> Questions	The teacher develops questions based on a structured thinking model, considering the stages of Design Thinking (<i>Empathize, Define, Ideate, Prototype, Test</i>).	Teachers frame questions more spontaneously and flexibly, focusing on solving problems that arise in interactions with learners.
Flexibility in Scaffolding Adjustment	Teachers make scaffolding adjustments based on objective analysis of learning observations and learner responses.	Teachers adjust Scaffolding quickly based on their instincts and experience with classroom dynamics
Use of Data in Developing Questions	The teacher collects data and analyzes learners' feedback to determine the correct type of questions to use in the <i>Design Thinking</i>	Teachers rely on experience and an emotional understanding of learners' needs to determine the direction of questions.

Indicator	Teacher with Analytical Contingency	Teacher with Intuitive Contingency
Reflection on Learning Outcomes	<p>process.</p> <p>The teacher systematically analyzes the learning outcomes to assess the effectiveness of the Scaffolding and questions provided.</p>	<p>Teachers reflect more based on their feelings or intuition about the dynamics and responses of learners during learning.</p>
Selection of Teaching Techniques	<p>Teachers select teaching techniques based on an in-depth analysis of the material and learners' characteristics.</p>	<p>Teachers choose teaching techniques based on instinct or personal experience in managing the classroom and facilitating learning.</p>
Evaluation and Feedback on Learners' Thinking Processes	<p>Teachers use structured evaluation instruments to measure how much learners have developed understanding and problem-solving through Design Thinking.</p>	<p>Teachers give personalized feedback based on direct observation of learners' thinking, often without in-depth analysis.</p>
Collaborative Approach to Learning	<p>Teachers encourage collaboration by analyzing the potential for cooperation between learners and how it supports the critical thinking process.</p>	<p>Teachers support collaboration naturally, encouraging discussion and sharing of ideas between learners based on a direct perception of group dynamics</p>
Integration of Mathematical Concepts in Design Thinking	<p>Teachers integrate mathematical concepts into the Design Thinking stages by considering the relationships between the concepts.</p>	<p>Teachers integrate math concepts based on their intuition and understanding of how learners respond to math learning.</p>
Adaptation to Learning Challenges	<p>Teachers analyze learning challenges and create data-driven solutions and analytical approaches to address them.</p>	<p>Teachers respond to learning challenges with creative approaches based on intuition and personal experience in dealing with similar situations.</p>

In implementing learning, teachers make adjustments to question Scaffolding based on objectively analyzing learning observations and learner responses. Teachers use learner

observations and responses to adjust scaffolding techniques, ensuring that teachers meet the diverse needs of learners (Dassa et al., 2024). Learning techniques are adjusted based on an in-depth analysis of the material and learners' characteristics. Teachers in learning also pay attention to collaboration between learners based on analyzing the potential for cooperation that supports the critical thinking process (Firdaus & Satriawan, 2025).

Teachers with intuitive contingency are more flexible and responsive to classroom dynamics. Teachers with this contingency often ask questions that open space for Exploration, encourage learners to think creatively, and connect concepts learned (Cotter et al., 2022). Teachers do not organize questions systematically but use more spontaneous questions by looking at learners' responses. Questions focused on understanding concepts and relationships between ideas in Mathematics. Scaffolding questions are open-ended so learners can explore various solutions to solving math problems (Nur et al., 2022)

In implementing learning, teachers choose learning techniques based on their experience in managing the classroom and facilitating learning (Zainuddin & Hardiansyah, 2023). Teachers support group learning, encourage discussion, and share ideas among learners. Teachers integrate mathematical concepts based on learners' responses to mathematics learning.

2) The relationship between teachers' thinking process strategies in providing scaffolding questions with design thinking content in mathematics learning in elementary schools

Based on the research results in providing Scaffolding, the questions are adjusted to the stages in design thinking. This can provide an understanding that scaffolding questions are made gradually until the mastery of students' level of understanding. The *scaffolding* questions with the *design thinking* approach can be explained as follows:

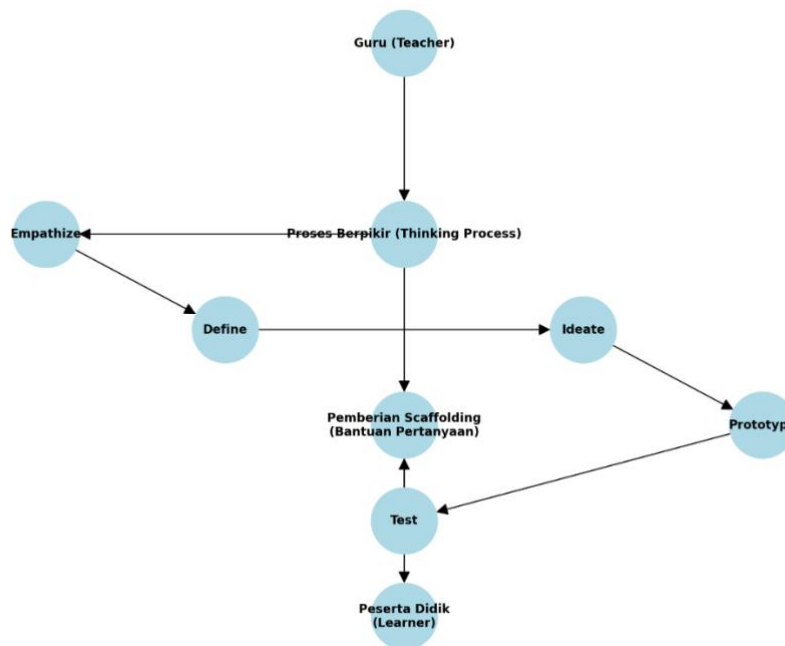
Table 3.3 Implementation of Design thinking-based Scaffolding in Mathematics Learning in Elementary Schools

Design Thinking Stage		Scaffolding
Stage 1 Empathy: Understanding Learners' Perspectives		<ul style="list-style-type: none"> a. The teacher asks exploratory questions such as, "How did you understand this problem? What did you find difficult?" b. Use everyday stories or scenarios relevant to learners, such as the example of buying goods in a shop, to introduce the concept of fractions. c. The teacher provides visual aids, such as diagrams or illustrations, to help learners understand the problem differently.
Stage 2 Definition: Formulating Problem	a	<ul style="list-style-type: none"> a. The teacher provides a concept map or framework to help learners organize the steps in defining the problem. b. Asking questions like, "What exactly is being asked in this problem? How can we determine it?"

Design Thinking Stage	Scaffolding
	c. Provide a list of keywords or math symbols related to the problem.
Stage 3 Ideation: Finding Creative Solutions	a. The teacher facilitates the brainstorming session with questions like, "What are some ways we can use to solve this problem?" b. Provide table or chart templates that help learners organize their ideas. c. Encourage learners to make predictions and explain the reasoning behind learners' ideas.
Stage 4 Prototype: Testing the Solution	a. The teacher provides the first step to constructing a solution, such as an example of solving a similar problem. b. Provide physical aids, such as number blocks, graph paper, or other manipulatives, to make it easier for learners to construct solutions. c. Asking questions, "What if we try this method first? What do we need to change if it does not work?"
Stage 5 Testing: Verifying the Solution	a. The teacher asks learners to check their answers by asking, "How do you know this solution is correct?" b. Provide a simple checklist to verify problem-solving steps. c. Asking reflective questions, such as, "Is there a simpler or faster way to solve this?"

The relationship between the teacher's thought process, Scaffolding, and its effect on learners using a *design thinking* approach. This approach involves five main stages: *empathize*, *define*, *ideate*, *prototype*, and *test*. Each stage contributes to helping teachers provide relevant questions or *Scaffolding* to learners. From the chart, it can be explained that each teacher has a thinking process influenced by the mastery of material concepts and learning activities (Novitasari, 2022; Parrales et al., 2020). One of the teachers' thinking processes can be seen gradually from scaffolding questions to students. *Scaffolding* can be done using steps or stages from the *design thinking* approach. *Design Thinking* supports Scaffolding with a creative problem-solving-based approach (Adinda Adinda et al., 2024). The role of the teacher's thought process in providing question scaffolding with the design thinking approach can be explained through the following chart:

Hubungan Proses Berpikir Guru dan Pemberian Scaffolding dengan Pendekatan Design Thinking



3) Strengths and weaknesses in implementing teacher thought process strategies in scaffolding design thinking questions in mathematics learning at elementary school.

The results showed that teachers with analytical contingency and teachers with intuitive contingency in providing question scaffolding have differences in their implementation. Thus, from these differences, the advantages and disadvantages of each contingency can be seen. The following table presents the advantages and disadvantages between teachers with analytical contingency and teachers with intuitive contingency in the context of scaffolding questions in mathematics learning.

Table 3.4 Strengths and weaknesses between teachers with analytical contingency and intuitive contingency in scaffolding questions in mathematics learning.

Aspects	Teacher with Analytical Contingency	Teacher with Intuitive Contingency
Strengths	Facilitate procedural understanding: Teachers can help learners to understand and follow procedures.	Encourage learners' creativity: Open up space for learners to explore different ways of solving problems.
	Very effective for problems that require systematic steps: Structured learning is perfect for problems that require a precise sequence of steps.	Flexibility in adapting learning: Teachers can respond to learners' individual needs more personalized and flexibly.
	Improve accuracy in answering problems: Learners tend to follow correct procedures	Increase learner engagement: Provides opportunities for learners to be more active in

Aspects	Teacher with Analytical Contingency	Teacher with Intuitive Contingency
	and improve accuracy in solving problems.	the learning process and discussions.
	Can address procedural errors appropriately: Teachers can easily analyze and correct errors step by step.	Build deeper conceptual understanding: Learners more easily understand the relationships between different concepts in math.
Weaknesses	<p>Too structured and rigid: Sometimes, this approach does not allow learners to explore alternative ideas or ways of solving problems.</p> <p>Less emphasis on creativity: Overly procedural learning can reduce the opportunity for learners to think creatively or find more efficient solutions.</p> <p>Less adaptive to different learners' needs: If learners struggle with procedures, this approach may lack the flexibility to adapt to their specific needs.</p> <p>Too much focus on the product, not the process: Learners tend to focus only on how to get the answer, not on understanding the underlying process.</p>	<p>Risk of learner confusion: Without a clear structure, some learners may feel confused and not know what steps to take next.</p> <p>It is challenging to direct learners who need a more transparent structure. Some learners may find it difficult without more systematic and structured guidance.</p> <p>Prone to disorganization in teaching: This approach can seem unfocused or random, especially if the teacher cannot organize the learning flow well.</p> <p>Requires high skills from the teacher: Teachers need to respond to learners' needs quickly and appropriately, which can be challenging in dynamic classroom situations.</p>

Strengths of teachers with an analytical contingency on scaffolding questions in Mathematics learning in Elementary Schools, namely the first learning activities, are more structured because, with the scaffolding questions from systematic teachers, students follow the correct steps in solving Mathematics problems (Esparcia et al., 2024; Kim & Choe, 2024). The learning steps are stimulated using various scaffolding questions the teacher has prepared. The second advantage is that problem-solving results are more certain because, with clear scaffolding questions, students can easily follow the procedure for solving mathematics problems (Dhahir & Sulistyarini, 2021; Handayani & Kurniasari, 2023). The third advantage is that when students make mistakes in problem-solving, the teacher can easily analyze the problem and then the teacher provides assistance to these students (Adytia Putri et al., 2023;

Pomalato et al., 2020).

The advantages of teachers with intuitive contingency are that they are the first to encourage creative ideas from students. This is because teachers with intuitive contingency provide more opportunities for students to find problem-solving solutions to encourage students to explore and be creative. The second advantage is responsiveness to the needs of each learner. Intuitive contingency teachers are more flexible in adjusting scaffolding questions to the conditions of learners (Farias & Isabel, 2022). Teachers, in providing Scaffolding, pay attention to the differences in learners' abilities. Moreover, the third is that learners' involvement in learning increases. Learners tend to be more actively involved in learning because they can think and discuss openly (Farias & Isabel, 2022).

CONCLUSION

The teacher's strategy for providing scaffolding of design thinking questions in elementary school mathematics learning begins with the planning, implementation, and evaluation stages. The strategy is implemented according to the design thinking stage, but the technical implementation is tailored to the teacher's characteristics. Teachers with analytical contingencies focus on logic and structured procedures, using carefully designed questions to help students think systematically and critically. Meanwhile, teachers with intuitive contingencies more often provide questions that open up space for exploration, encouraging students to think creatively and connect concepts they have learned.

The relationship between the teacher's thinking process, the provision of scaffolding, and its influence on students using the design thinking approach involves five main stages: empathize, define, ideate, prototype, and test. Each stage contributes to helping teachers provide relevant questions or assistance (scaffolding) to students. Every teacher has a thinking process that is influenced by their mastery of the material concept and the learning activities they carry out. One of the teacher's thinking processes can be seen from the provision of scaffolding questions to students in stages. Scaffolding can be done using steps or stages of the design thinking approach.

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