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Application of Scaffolding on Ethnomatematics-Based Construction Errors

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Abstrak

Kesalahan dalam pembentukan konsep matematika sering dilakukan oleh siswa. Diperlukan bantuan berupa scaffolding untuk mengatasi permasalahan tersebut. Penelitian dengan metode kualitatif deskriptif ini bertujuan menganalisis kesalahan siswa dalam mengkonstruksi konsep bangun datar dengan pemberian scaffolding. Subjek penelitian yaitu empat siswa kelas VII salah satu SMP di Jembe, yang dipilih dengan teknik purposive sampling. Subjek tersebut mempunyai kriteria melakukan banyak kesalahan dan memiliki keterampilan komunikasi lisan yang baik. Instrumen penelitian berbentuk soal tes. Teknis analisis data dilakukan dengan reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan scaffolding conceptual development sesuai untuk mengatasi kesalahan konstruksi konsep pada indikator pseudo contruction "Benar" pseudo contruction "Salah". Scaffolding explaning tepat untuk indikator lubang konstruksi dan Mis-analogical Construction, sedangkan scaffolding reviewing tepat untuk indikator mis-logical contruction. Hasil pemberian scaffolding tersebut menunjukkan bahwa penerapan scaffolding yang sesuai dapat memperbaiki kesalahan kontruksi konsep yang dilakukaan oleh peserta didik.
Kata Kunci: Kesalahan Kontruksi Konsep; Bangun Datar Berbasis Etnomatematika; Scaffolding.

Abstract

Mistakes in forming mathematical concepts are often made by students. Assistance in the form of scaffolding is needed to overcome this problem. This research using a descriptive qualitative method aims to analyze students' errors in constructing the concept of flat shapes by providing scaffolding. The research subjects were four class VII students from one of the junior high schools in Jembe, who were selected using a purposive sampling technique. This subject has the criteria of making many mistakes and having good oral communication skills. The research instrument is in the form of test questions. Technical data analysis is carried out by data reduction, data presentation, and drawing conclusions. The research results show that scaffolding conceptual development is suitable for overcoming conceptual construction errors in the "Correct" pseudo construction and "Incorrect" pseudo construction indicators. Scaffolding explaning is appropriate for construction hole indicators and Mis-analogical Construction. Meanwhile, scaffolding reviewing is appropriate for indicators of mis-logical construction. The results of providing scaffolding show that applying appropriate scaffolding can correct concept construction errors made by students.
Keywords: Concept Construction Error; Ethnomatematics-Based Flat Building; Scaffolding.

I. INTRODUCTION

The process of linking one concept to another to generate new knowledge is termed concept construction (Safitri & Jaenudin, 2021). Concept construction is integral to learning mathematics, aligning with the assertion by Sutama et al. (2020) that mathematics learning involves creating new concepts in connection with previously grasped ones. According to Putra et al. (2023), knowledge formation occurs when students actively engage in the construction process, utilizing previous concepts to understand subsequent ones.

Sihite et al. (2022) emphasize that in the learning journey, students employ existing thinking constructs to enhance their understanding comprehensively. This underscores the continuous and ongoing nature of the construction process (Umbara, 2017). Proficiency in concept construction is vital for students in problem-solving and facilitating their learning process (Purwanti et al., 2016).

Despite the potential for success in students' concept construction endeavours, it is not always achieved. There are two possible outcomes when constructing mathematical concepts: success or failure (Anggraini et al., 2018). Student difficulties in concept construction and problem-solving can lead to process failures (Inganah et al., 2021), often evident in the mistakes made while tackling mathematical problems (Muqtada et al., 2022).

Errors in concept construction refer to deviations from the formal concepts essential in the mathematical construction process. Understanding mathematical concepts involves constructing and reconstructing mathematical objects (Ningsih, 2018). This systematic process comprises sequential steps to form objects in a scheme aimed at problem-solving (Putra et al., 2023). Previous research by Ni'mah et al. (2018) identified four types of errors in constructing mathematical concepts: (1) pseudo construction, (2) construction holes, (3) mis-analogical construction, and (4) mis-logical construction.

Observations and interviews with a mathematics teacher at Nuris Jember Middle School revealed that most students struggle with developing mathematical concepts, particularly in abstract geometry, which demands strong visualization skills. Plane-shaped materials, covered in the seventh-grade curriculum, hold practical applications in daily life, such as the distinctive Jember batik motif, reflecting the local culture. This resonates with Wulandari et al.'s (2021) assertion that mathematics significantly influences daily life, as many activities involve the application of mathematical principles. The pivotal role of mathematics in developing human thinking is highlighted by Saraswati and Agustika (2020).

Exploring errors in the construction of flat shapes within cultural contexts, mainly through the lens of Jember batik, not only sheds light on conceptual challenges but also enriches our understanding of Jember's cultural heritage. Correcting students' mathematical and conceptual errors becomes crucial to prevent recurring mistakes (Susilowati & Ratu, 2018).

While efforts to enhance mathematical concepts through active student engagement are underway (Puspitasari & Santosa, 2021), real-world challenges

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persist in students' concept formation. Addressing these challenges requires providing *scaffolding* tailored to meet student needs (Laamena, 2019).

Scaffolding serves as a support mechanism, enabling students to tackle tasks beyond their current capabilities (Milazoni et al., 2022). Its primary objective is to empower students to approach problems more effectively, fostering independent problem-solving success. Teachers' *scaffolding* efforts encompass three levels: (1) environmental provisions, (2) explanation, review, and restructuring, and (3) conceptual development (Kristanti, 2020).

Applying *scaffolding* that aligns with students' needs facilitates improvements in constructing mathematical concepts. This resonates with Ni & Fathani's (2018) perspective that *scaffolding* aims to guide students in developing the correct mindset for constructing appropriate mathematical concepts. According to Komarudin (2016), appropriate *scaffolding* positively influences student development when facing problem-solving difficulties (Bakker et al., 2015). Susilo & Prihatnani (2022) further highlight *scaffolding*'s role in overcoming challenges in mathematics learning for students with special needs and general students.

Despite these insights, the application of *scaffolding* to address errors in students' concept formation, particularly in plane shapes, has not seen widespread implementation. Initial field observations reveal persistent errors among some students in constructing mathematical problems.

Given these considerations, and with the goal of reducing errors in students' construction of mathematical concepts, it becomes imperative to apply *scaffolding*. This research aims to analyze students' errors in constructing the concept of plane shapes by providing targeted *scaffolding* interventions.

II. METHOD

This study employed a qualitative descriptive research design conducted at a junior high school in Jember, focusing on the seventh-grade student population. The research subjects, PA1, PA2, PA3, and PA4, were selected using purposeful sampling techniques. These four students were chosen based on their shared characteristics of frequently making errors in answering questions and proficient oral communication skills that facilitated collaboration with the researchers.

Data collection involved administering a test emphasizing the resolution of higher-order thinking Skills (HOTS) questions grounded in ethnomathematics within the context of plane figures. The research employed an ethnomathematics-based instrument tailored for plane material. Figure 1 provides examples of the questions used in the study

Dalam motif batik khas jember seperti gambar diatas, terdapat motif yang bergambar bangun trapesium. Jika saya membeli batik khas jember dengan ukuran 3m x 2m dan motif sebuah trapesium yang ada pada batik khas jember dengan sisi sejajarnya berukuran 2cm dan 8cm dan tinggi trapesium berukuran 2cm. jarak antar bangun trapesium secara vertical dan horizontal masing-masing adalah 2cm. tentukan berapa banyak bangun trapesium yang ada pada batik khas jember tersebut!

Figure 1. Example of Questions of Plane Shapes Based on Ethnomathematics

Upon obtaining the answers, the researcher conducted unstructured interviews with the subjects to delve deeper into their understanding of errors encountered while working on ethnomathematics-based questions related to plane material, with the support of *scaffolding*. Unstructured interviews were chosen because the researcher had not predetermined the responses and intended to use the subjects' answers to formulate subsequent questions. The interview guide encompassed a core framework addressing the issues to be explored with the respondents.

The outcomes of both the question-solving process and the subsequent interviews were meticulously analyzed to pinpoint students' errors when tackling ethnomathematics-based questions on plane material with the aid of *scaffolding*. The analysis focused on students' proficiency in recalling and constructing knowledge to solve mathematical problems. Table 1 outlines the indicators used to identify errors in constructing mathematical concepts in this research.

Table 1.
Indicators of Mathematical Construction Errors

No	Error Type	Error Indicator
1.	Pseudo Construction "correct" Despite initially appearing correct, further investigation revealed that the student's answers were, in fact, incorrect.	Students provided the correct solution to a problem. However, it was discovered upon closer investigation that the student inaccurately explained or clarified their answer.
	Pseudo Construction "incorrect" The student's written response initially appeared incorrect. However, upon tracing the cause of the error, it was revealed that the student's thought process was accurate, leading to the correct formulation of the answer.	Although students initially provided incorrect answers to a problem, further exploration through interviews or reflection revealed that students possessed the correct thought process and could provide accurate answers.
2.	Construction Hole Errors from the thinking structure formed during the concept construction process are incomprehensive. While students can solve questions correctly, these errors hinder the complete formation of conceptual understanding.	Even though students provide correct answers, an inappropriate concept construction process occurs. The correct answers may not align with the students' fully formed conceptual understanding.
3	Mis-analogical Construction Errors arise when students equate one concept with another. For instance, in constructing roots and exponents, students mistakenly perceive these operations as identical to ordinary arithmetic operations.	Students provide incorrect answers when they erroneously equate one concept with another.
4.	Mis-logical Construction Errors arise due to students' logical misconceptions and a lack of understanding of the given questions.	Students provide incorrect answers because they struggle to reason and comprehend problems accurately, stemming from difficulties in thinking logically during problem-solving.

The data was then analyzed using technical analysis which focused on Miles and Huberman's opinions, including (1) data reduction, (2) data presentation, and (3) drawing conclusions.

III. RESULT AND DISCUSSION

The results of the analysis show that in solving plane shapes problems based on ethnomathematics, there are still many students who make mistakes. Corrective steps are needed so that students avoid making the same mistakes and can solve a problem correctly. Educators need to direct students through question-and-answer interactions so they can correct the mistakes they make. The following is an explanation of the steps applied for each error in concept construction.

A. Pseudo Construction “correct”

This type of error was made by subject PA3. The subject gave the correct results, but after tracing, the subject took the wrong steps in answering the question. The following are subject PA3's answers before being given *scaffolding*.

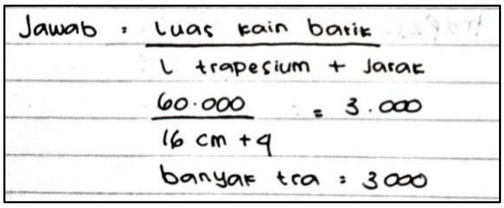


Figure 2. The answer of PA3 Before Providing *Scaffolding*

Figure 2 shows subject PA3 writing down an inaccurate work process. Subject PA3 should have calculated the sum of the area of the trapezoid and the distance first. So, 60,000/16+4 = 60,000/20 = 3000.

Based on the results of the interview, subject PA3 has given the correct results. However, the survey results revealed that subject PA3 wrote the answer incorrectly. Therefore, the *scaffolding* applied to correct PA3 subject errors is to provide support at the conceptual development level. The teacher's role is to help students in developing concepts mastered by students or building relationships between different concepts.

After the researcher provided *scaffolding* that was appropriate to subject PA3's error, then subject PA3 corrected the wrong answer. The following is subject PA3's answer after being given *scaffolding*.

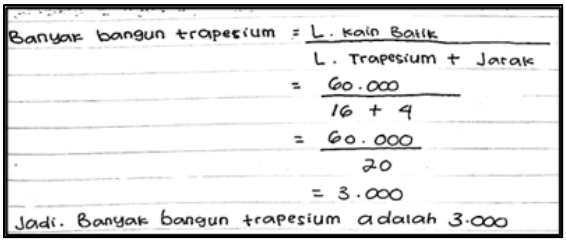


Figure 3. The answer of PA3 After Providing *Scaffolding*

From the results of subject PA3's answers in Figure 3, it is known that subject PA3 can solve the problem precisely and correctly, therefore providing *scaffolding* for indicators (Pseudo Construction "correct") is in accordance with the needs of students.

B. Pseudo Construction ” incorrect”

Based on the mistakes made by subject PA1 and subject PA2, the researcher conducted an interview with subject PA1, where subject PA1 made the wrong answer in solving the questions. The following is subject PA1's answer before being given *scaffolding*.

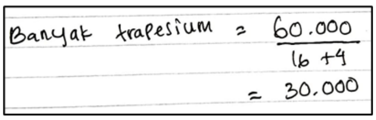


Figure 4. The answer of PA1 Before Providing *Scaffolding*

From the results of subject PA1's answer, it is known that subject PA1 wrote the wrong answer at 60,000/16+4 = 30,000.

The interview results showed that subject PA1 had provided wrong results. This type of error is in line with research (Wulandari et al., 2021) which states that errors occur because students have not been able to develop concepts they have mastered or establish relationships between other concepts.

Therefore, *scaffolding* is needed to correct these errors. The *scaffolding* used to correct errors in subject PA1 is by providing support at the conceptual development level. The teacher's role is to help students improve concepts that have been mastered by students or establish relationships between different concepts. The following is subject PA1's answer after being given *scaffolding*.

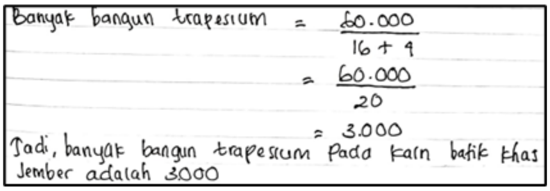


Figure 5. The answer of PA1 After Providing *Scaffolding*

From the results of subject PA1's answers in Figure 5, it is known that subject PA1 was able to solve the problem precisely and correctly. Likewise for subject PA2. Therefore, providing *scaffolding* for indicators (Pseudo Construction "incorrect") is in accordance with students' needs.

C. Construction Hole

In this type of error, students work out the correct answer, but there are steps in constructing the concept that is not appropriate. Students work on correct results, but this concept has not yet been fully formed clearly in students' thinking. This type of error is in line with research conducted by (Muqtada et al., 2022) showing that student errors are formed because of the incomplete structure of students' thinking. This error was made by subjects PA1, PA2, PA3 and PA4.

In the interview conducted by the researcher, subject PA2 stated that he gave the right answer. However, there was a concept construction process that did not match expectations. The following are subject PA2's answers before being given *scaffolding*.

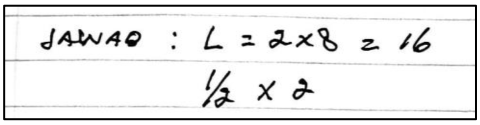


Figure 6. The answer of PA2 Before Providing *Scaffolding*

From the mistakes made by subject PA2 in Figure 6, it is known that subject PA2 wrote down the process of working out the area of a trapezoid incorrectly, subject PA2 should have worked out the area of a trapezoid as follows: L. Trapezium formula = 1/2 x t x number of parallel sides = 1/2 x 2cm x 16cm = 16cm^2.

From the results of the interview, subject PA2 wrote the correct results. However, there are problems in concept construction that occur to students. To overcome this, the *scaffolding* used is at the Explanation level.

Teachers play a role in explaining concepts when students do not have knowledge or experience forgetfulness. Students are also expected to have a clear understanding of their ideas while actively participating in the learning process.

After the researcher provides *scaffolding*, the students correct their answers. The results of the students' corrected answers show that the students' answers are correct. This shows that the process of providing *scaffolding* for construction hole indicators is to the needs of subject PA2. The following are subject PA2's answer after being given *scaffolding*.

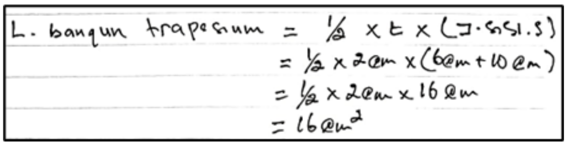


Figure 7. The answer of PA2 After Providing *Scaffolding*

D. Mis-analogical Construction

Based on the mistakes made by subject PA3 and interviews conducted by researchers with subject PA3, it is known that subject PA3 gave the wrong answer in solving the questions. The following are subject PA3's answer before being given *scaffolding*.

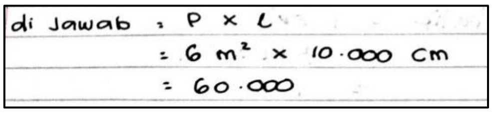
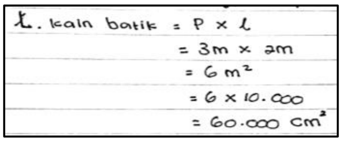


Figure 8. The answer of PA3 Before Providing *Scaffolding*

From subject PA3's answer in Figure 8, it is known that subject PA3 wrote the wrong concept construction process on the area of a rectangle = p x l = 6m^2 x 10,000cm = 60,000.

From the results of the interview, subject PA3 worked out the correct answer. However, there are problems in concept construction that occur in the PA3 subject. This form of mis-analogical construction error is in line with the results of errors in research (Angraerni, et al., 2021) which shows that students write wrong answers because students equate one concept with another concept. To overcome this, the *scaffolding* used is at the Explanation level. Teachers play a role in explaining concepts when students do not have knowledge or experience forgetfulness. Students are also expected to have a clear understanding of their ideas while actively participating in the learning process.

After the researcher provided *scaffolding*, subject PA3 then corrected his answer and the results showed that the student's answer was correct. This shows that the process of providing *scaffolding* for the Mis-analogical Construction indicator is in accordance with the needs of subject PA3. Picture of PA3 students' answers after being given *scaffolding*..



Gambar 9. The answer of PA3 After Providing *Scaffolding*

E. Mis-logical Construction

In this type of concept construction error, students work on the wrong results because they do not understand the problem correctly. Students cannot think logically in working on the problem. This type of error is in line with research (Sulfriani, et al., 2021), that error made by students in this type are because students do not understand the concept. This type of error was made by subject PA4. Subject PA4's answers before being given *scaffolding* are presented in Figure 10.

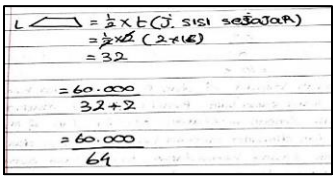


Figure 10. The answer of PA4 Before Providing *Scaffolding*

Figure 10 shows that subject PA4 was unable to solve the problem correctly. Subject PA4 wrote the wrong results when determining the area of the trapezoid and also when determining the number of trapezoid motifs on typical Jember batik cloth.

Based on the results of the interview, subject PA4 noted that the answer was wrong because subject PA4 was unable to analyze the questions correctly and lacked an understanding of the concept. To overcome these errors, the *scaffolding* approach used is at the Reviewing level. The role of the teacher is to refocus students' attention and give them more time to understand the problem while helping them solve the problem through their own understanding.

After the researcher provided *scaffolding*, subject PA4 then corrected his answer. The results of subject PA4's corrected answers show that the student's answers are correct. This shows that the process of providing *scaffolding* for the Mis-logical Construction indicator is in accordance with the needs of subject PA4. Figure 11 shows subject PA4's answer after being given *scaffolding*.

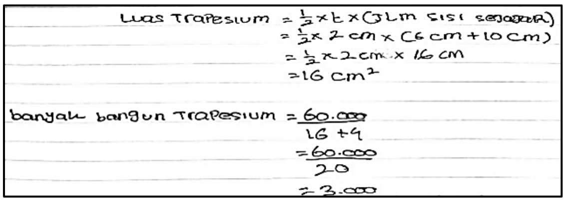


Figure 11. The answer of PA4 After Providing *Scaffolding*

F. Data Interpretation

Based on the previous description, the data produced in this research can be detailed based on data analysis techniques that focus on Miles and Huberman's analysis in research (Wulandari et al., 2021) which includes data reduction, data presentation, and drawing conclusions. The results of the data analysis will be described below.

1. Data Reduction

Data reduction is steps to reduce or simplify the information contained in the data. In the context of classifying students who make concept construction errors, data reduction refers to selecting and grouping students based on their errors in understanding or applying certain concepts. Table 3 shows the classification of students who made concept construction errors in ethnomathematics-based plane figure questions.

Table 2.
Classification of Misconstructions of The Concept Before Providing *Scaffolding*

Indicator	SUBJECT			
	PA1	PA2	PA3	PA4
PCB	TTK	TTK	TK	TTK
PCS	TK	TK	TTK	TTK
LK	TK	TK	TK	TK
MAC	TTK	TTK	TK	TTK
MLC	TTK	TTK	TTK	TK

dimana:
PCB : Pseudo Contruction "correct"
PCS : Pseudo Contruction "incorrect"
LK : Construction Hole
MAC : Mis-analogical Construction
MLC : Mis-logical Construction
TTK : No Error Occurred
TK : Error Occurred

2. Data Presentation

Presentation of data, namely, arranging types of conceptual construction errors in flat building materials based on the use of *scaffolding*. Table 3 shows the types of indicators of errors in concept construction and *scaffolding*.

Table 3.
Indicators of Construction Concept
and *Scaffolding* Errors

Subject	Indicator	Providing *scaffolding*
PA1	PCS	*Conceptual development*
	LK	*Explaining*
PA2	PCS	*conceptual development*
	LK	*Explaining*
PA3	PCB	*conceptual development*
	LK	*Explaining*
	MAC	*Explaining*
PA4	LK	*Explaining*
	MLC	*Reviewing*

3. Draw Conclusions

Concluding is drawing out the results of conceptual construction errors after providing appropriate *scaffolding* for the error made by each student. The results of students' concept construction errors in table 4 are presented after the *scaffolding* was applied.

Table 4.
Construction Errors After *Scaffolding*

Indicator	SUBJECT			
	PA1	PA2	PA3	PA4
PCB	TTK	TTK	TTK	TTK
PCS	TTK	TTK	TTK	TTK
LK	TTK	TTK	TTK	TTK
MAC	TTK	TTK	TTK	TTK
MLC	TTK	TTK	TTK	TTK

Based on data analysis, it is known that the application of *scaffolding* is effective in helping overcome students' conceptual construction errors. This is due to the provision of *scaffolding* that is appropriate to the level applied, such as conceptual development, explanation, restrictions, and review. This is in line with research Susilowati and Ratu (2018), also Al-Qonuni and Afriansyah (2023) research which states that providing support to students who experience errors in learning mathematics or other materials can correct students' mistakes when solving problems.

These results are the aim of implementing *scaffolding*, namely providing a type of encouragement that allows students to overcome problems, do assignments, or achieve their goals through the learning process, this is in line with Masnia and Amir (2019), also Handoko and Winarno (2019) research. Providing *scaffolding* supports students in improving the mindset needed to achieve the correct final results, in line with Ni'mah et al. (2018), and Fitriya, Kurniawan, and Latif (2023) research also.

Teachers have the flexibility to choose *scaffolding* strategies that can support students in overcoming learning difficulties. In general, students often face difficulty in learning, especially when they encounter new material or information. Every educator, adult, or expert can also use *scaffolding* in everyday life. To carry out *scaffolding* correctly and effectively, sufficient practice and expertise are required. *Scaffolding* has advantages and disadvantages. Teachers are expected to be able to take advantage of the advantages and minimize the disadvantages of the *scaffolding* provided.

IV. Conclusion

The results of this research show that concept construction errors for the "correct" Pseudo Construction indicator were only made by PA3 students and for the "incorrect" Pseudo Construction indicator were made by PA1 and PA2 students. For hole indicators, construction was carried out by all subjects (PA1, PA2, PA3 and PA4).

The Mis-analogical Construction indicator is only carried out by PA3 students, and the Mis-logical Construction indicator is only carried out by PA4 students.

Concept construction errors in the "correct" pseudo-construction and "wrong" pseudo-construction indicators are caused by students' lack of accuracy in the process of answering questions. Conceptual construction errors in the construction hole indicator occur due to students' lack of understanding of the concept. Meanwhile, in the mis-analogical construction indicator, errors occur because students are wrong in determining the correct formula. As for the mis-logical construction indicator, errors occur due to students' lack of accuracy in carrying out calculations.

The conceptual development stage is a form of *scaffolding* that is suitable for overcoming conceptual construction errors in the "Correct" pseudo-construction indicator as done by PA3 students and the "Wrong" pseudo-construction indicator as done by PA1 and PA2. Furthermore, suitable *scaffolding* is used as an indicator of construction holes that occur in all subjects and mis-analogical construction in PA3, namely the explanation stage. Finally, *scaffolding* that is suitable for use as indicators of mis-logical construction as carried out by PA4 students is the Reviewing stage.

Based on the results of research that has been carried out, the author recommends that teachers be able to recognize weaknesses in conceptual designs made by students when working on problems, as well as provide assistance (*scaffolding*) to students who face difficulties or deficiencies in learning the concept of flat shapes and other material. The benefits gained from applying *scaffolding* to ethnomathematics-based plane material questions are not only correcting students' conceptual construction errors but indirectly the teacher introducing a culture to students.

It is hoped that this research can guide subsequent research related to conceptual construction errors in solving flat figures based on ethnomathematics and the application of *scaffolding*.

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