

E-Scaffolding of Matriks Material Mathematics Learning Through Online Learning

Fitri Umardiyah^{1*}, Alfi Nur Laili²

^{1,2}Mathematic Education, Universitas KH. A. Wahab Hasbullah

*Email: Fitriumardiyah@unwaha.ac.id

ABSTRACT

Paradigms in learning mathematics have an impact on changing emphasis in the learning process. Students who have difficulty solving problems in the learning process are one of the factors that need improvement. Educators who dominate conversations and interactions in the classroom, explanations of material that only refer to the completeness of the curriculum make students experience difficulties when solving math problems. Not all difficulties in learning mathematics considered as errors, but difficulties in solving mathematical problems may contain errors in learning mathematics. Difficulties in learning mathematics experienced by students also mean learning difficulties in parts of mathematics. Therefore, in this study e-scaffolding can be an innovation and also an alternative in providing assistance to students who have lower abilities in the Zone of Proximal Development (ZPD) carried out by educators. With an online or electronic basis that adapts to conditions in the midst of a pandemic like today. For an educator, it is necessary to know the difficulties experienced by students in the learning process. The difficulties experienced by students seen in solving the questions given. Problems that not immediately addressed will result in a lack of students' understanding of further higher mathematical concepts. This study shows that e - scaffolding, provides effective understanding in learning activities, greatly assisting students in understanding the concepts and materials that have given, especially in the matrix material, so to improve students' cognitive understanding.

Keywords: *E-Scaffolding; Online Learning; Matrix.*

INTRODUCTION

The problems of students that often arise in learning at the Aliyah level: difficulty in understanding mathematics, one of which is matrix material. Matrix material can be said to be one of the materials that is quite relevant and easy to work with. Only in not few field that need in-depth understanding to understand the concept of the material. This can be see when research carried out by giving a question related to matrix material.

What can educators do to find out the thinking process of students' understanding? One of them is by giving test questions. When students can answer the questions given, the response that students give can be an indicator that students are thinking and thinking process at a certain level. Efforts to provide assistance students made online or remotely. Scaffolding is assistance provided by educators and more competent peers, in providing some assistance to students during early stages of learning and then reduce assistance and provide opportunities for students to students to take on greater responsibility as soon as he is able do it themselves (Saputi & Wilujeng, 2016, p.). (*Scaffolding Practices That Enhance Mathematics Learning.Doc*, n.d.) Anghileri, (2006) in providing scaffolding there are three levels as follows; Environmental provisions (classroom organization, artefact), explaining, reviewing and restructuring, developing conceptual thinking.

The results of the study (Ayu et al., 2017) show that e-scaffolding provides freedom students to develop their ability to understand and solve problems in learning according to their level of understanding. Online-based scaffolding give provide the opportunity freely use the time in learning and understanding material that has given. Students are expected to get feedback direct results of assistance in the form of explanations from educators regarding the difficulties they had at time work on the given

question. Based on the explanation, the objectives set in the research to describe the provision of *e-scaffolding* to students in the process learning according to the ability of each student on the matrix material.

METHOD

This research is a descriptive qualitative research, and in this research is more emphasizes the working process in research. The test questions used in this study is a diagnostic test in the form of five description questions. The subjects of this study taken from student class XI and XII MIPA at MA Unggulan KH. Abdul Wahab Hasbullah Tambakberas Jombang and Senior High School Madinatul Ulum Tembelang Jombang. According to (Nur Afifah et al., 2018) not only students only those with low abilities have difficulty understanding a material, but students with moderate and high abilities can also experience difficulties which are characterized by the inability of students to solve problems correctly and completely. Therefore, the research conducted by in-depth interviews with each student individually one by one online.

Researchers compiled a test sheet that serves as an instrument to see students' abilities. The preparation of the test based on the material that has taught to the students of class XI MIPA. Researcher compiling interview guidelines and *e-scaffolding* guidelines. In addition, researchers also play a role as a provider of *e-scaffolding* to a predetermined subject.

RESULT AND DISCUSSION

Result

Retrieval of research data begins with selecting the subject studied. Researcher give test 1 which contains five matrix material questions including transpose, inverse, and determinant matrix. Based on the results that have done by 45 students of class XI MIPA and 30 class XII MIPA MA Unggulan KH. Abdul Wahab Hasbullah Tambakberas and 29 students of class XII MIPA Senior High School of Madinatul Ulum Tembelang Jombang, is the subject of research in working on test questions.

- S1 ability in solving matrix material

1. Value $B = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$ and $B + C = \begin{bmatrix} 2 & 1 \\ -3 & 1 \end{bmatrix}$, if A is a matrix of size 2x2 so that $AB + AC = \begin{bmatrix} 4 & 2 \\ -3 & 1 \end{bmatrix}$. Then determinant of AB is....

Figure 1. Question of The Test Question Number 1

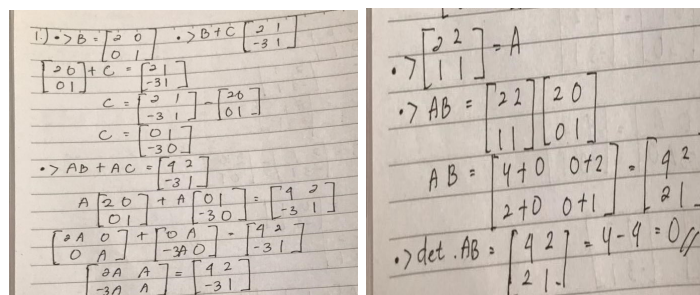


Figure 2. Answer of The Test Question Number 1

For, test question number 1, Subject 1 could not complete the work on the question. Figure 2is the result of S1's work for test number 1. S1 looks for the value of the C matrix obtained from subtraction between the B+C matrices. Masters understands what to look for first to find matrix that has known in the problem (able to find the value of matrix C). However, as a result S1's lack of understanding of the properties of matrices, in this case in matrix multiplication. The process that done S1 in the solution is wrong. For addition and subtraction done already true, it is just that when the next step finds the value of A, the solution is not right. In finding the value of a matrix, you can use the inverse product A (B+C). Matrix A still has four elements or a matrix that has the order of 2x2, cannot directly multiplied with matrix B or C. So it can solved by assuming the matrix A, namely a b c d.

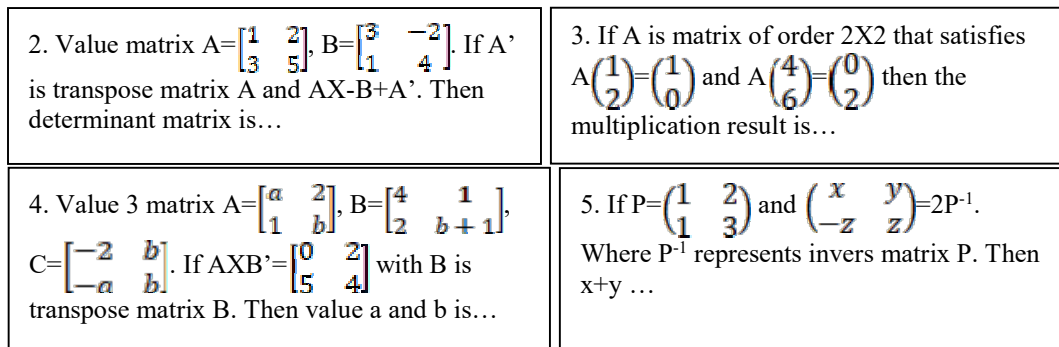


Figure 3. Question of The Test Question Number 2,3,4,5

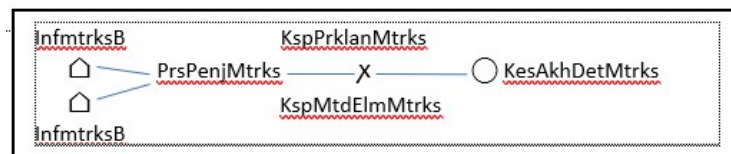


Figure 4. S1 Response Scheme for Test Question Number 1

Table 1. Description of the Code in the S1 Response Scheme for Test Question Number 1

No	Code	Information
1	⊡	Information or clues provided that can prompt a response
2	○	Response, either intermediate or final result
3	X	Wrong concept or process
4	InfmtrksB	Information on the value of the B matrix in the question
5	InfmtrksB+C	Information on the value of the B+C matrix in the question
6	PrsPenjMtrks	Matrix addition process
7	KspPrklanMtrks	The concept of matrix multiplication
8	KspMtdElmMtrks	Concept of method of elimination, substitution in matrices
9	KesAkhDetMtrks	The final conclusion reached about the determinant of the matrix

Based on S1's response scheme for question 1, it can be seen that S1 cannot provide example in solving matrix multiplication $AB + AC$. The matrix should be given for example, for matrix A, it does not directly enter the existing matrix values. As a result, the conclusion looking for the determinant of AB has an error and is irrelevant to the result.

- Giving E - Scaffolding to S1 Based on Test Results 1.

Table 2. Description of Test and Interview Results to Subject 1

No	Description	Problem faced by S1	Scaffolding shape which is given	S1's reaction to the scaffolding given
1	The process that done S1 in complete question number 1 wrong.	S1 does not understand the properties multiplication in the matrix. S1 considered the solution always remains enter numbers in known formula. While in this matter need as eparation to give ease of work	Researchers provide explanation n about traits multiplication correct matrix. There are traits owned by matrix on multiplication matrix.	After listening researcher explanation, S1 start to understand multiplication property of matrix, and start getting give solution

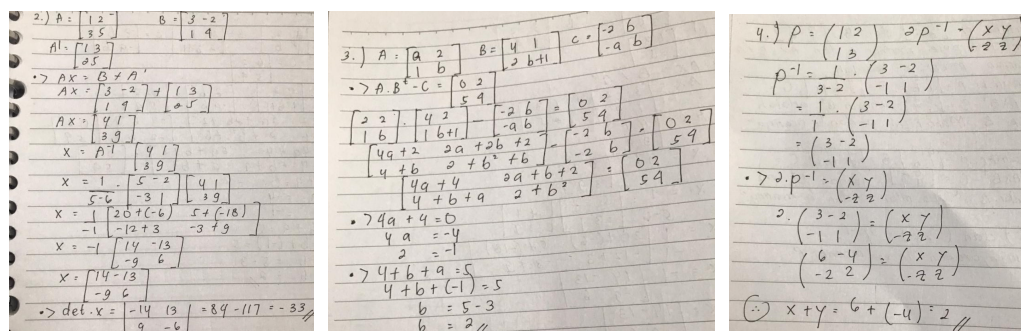


Figure 5. S1 Work Results for Test 1 Question Number 2 (left), 3 (middle), 4 (right)

From the results of S1 work and interviews conducted, for questions number 2, 3 and 4, S1 has use all the information contained in the problem and can apply the concept or process correctly and can draw relevant conclusions. In accordance with the concept of matrix material wherein determining the transpose of the matrix by writing the elements in matrix A into element-element in the column. The determinant formula is the value of $a_1b_1 - a_2b_2$. S1 was able to find results from determinant X, which is 33.

- Master's ability S2 in completing matrix material

Master's ability in solving matrix problems seen through the results of Master's work on test item 1 given. In Figure 1, S2 can answer the questions correctly. Figure 9 below is the result of master's work for test number 1

Figure 6. Work Results S2 Number 1

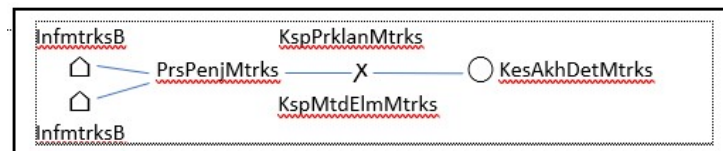


Figure 7. S2 Response Scheme for Test 1 Question Number 1

From the results of the work that completed, S2 can understand the initial concept of the problem asked. S2 succeeded in determining the value of the matrix C. The next solution, S2 experienced obstacles that cause unable to determine the result (not coherent). S2 cannot understand the next flow, namely matrix multiplication. In a given problem, the matrix multiplication that given leads to find the value of the matrix A. From here, S2 loses understanding in find the value of the matrix A, and cause an incorrect answer.

Table 3. Description of the Code in the S2 Response Scheme for Test Question Number 1

No	Code	Information
1	⏏	Information or clues provided that can prompt a response
2	○	Response, either intermediate or final result
3	x	Wrong concept or process
4	InfmtrksB	Information on the value of the B matrix in the question
5	InfmtrksB+C	Information on the value of the B+C matrix in the question
6	PrsPenjMtrks	Matrix addition process
7	KspPrklanMtrks	The concept of matrix multiplication
8	KspMtdElmMtrks	Elimination method concept, substitution in matrix
9	KesAkhDetMtrks	The final conclusion obtained about the determinant of the matrix

Looking at the response scheme of S2, we get a description that is in the process of obtaining the sum of the two matrices has been successful. The rules for multiplying two matrices have not mastered, resulting in an irrelevant value. Starting from that, the solution for next in a row wrong. The provision of *e- scaffolding* carried out via WhatsApp Video Call as a one of the alternatives in helping the solution.

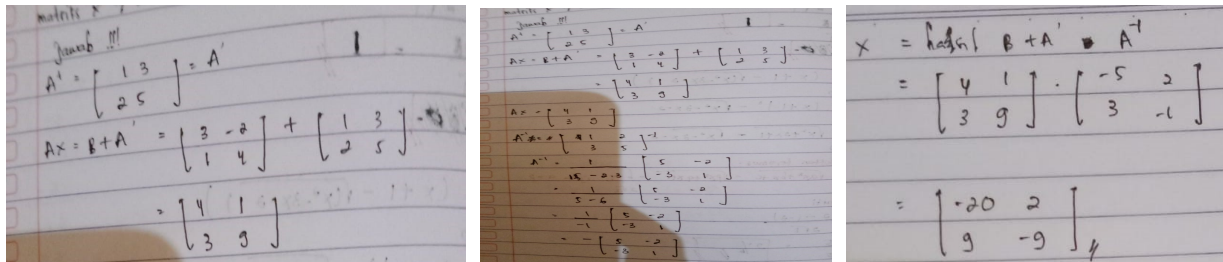


Figure 8. Results of S2 work for Test 1 Question Number 2.

From the results of working on test number 2, S2 understands the problems given by the questions. S2 able to change the value of matrix A into matrix A' (transpose) and can also add up matrix B with matrix A'. Subsequent settlement S2 has difficulty in determining the solution. S2 does not know what to do after that. It can be seen from the results of the work in Figure 11. From the figure, it can be seen that S2 determines the value of the invers A after obtaining *e-scaffolding* from researchers.

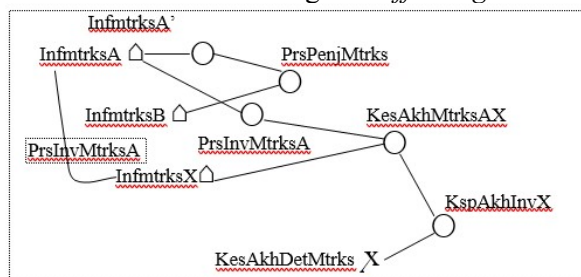


Figure 9. S2 Response Scheme for Test 1 Question Number 2

Table 4. Description of the Code in the S2 Response Scheme for the Test Question Number 2

No	Code	Information
1	△	Information or clues provided that can prompt a response
2	○	Response, either intermediate or final result
3	×	Wrong concept or process
4	InfmtrksA	Information on the value of the matrix A in the question
5	InfmtrksB	Information on the value of the B matrix in the question
6	InfmtrksA'	The large information matrix A is the unwritten transpose matrix on the question (estimated S2 after looking at matrix A)
7	PrsInvMtrksA	Matrix inverse process A
8	PrsPenjMtrks	Matrix addition and subtraction process
9	KspPrklanMtrks	Matrix multiplication concept
10	KspMtdElmMtrks	Concept of determinant of matrix
11	KesAkhMtrksAX	The final conclusion about the matrix multiplication AX
12	KspAkhInvX	The final conclusion about the inverse matrix X
13	KesAkhDetMtrks	The final conclusion obtained about the determinant of the matrix X

The response scheme in Figure 12, S2 can use the information contained in the problem and can apply the concept or process of addition to the inverse correctly, giving the result temporary and linking information or other processes. So that we can draw conclusions only until the inverse of the matrix A. to continue to find the determinant of the matrix, S2 is a misconception with the formula that obtained.

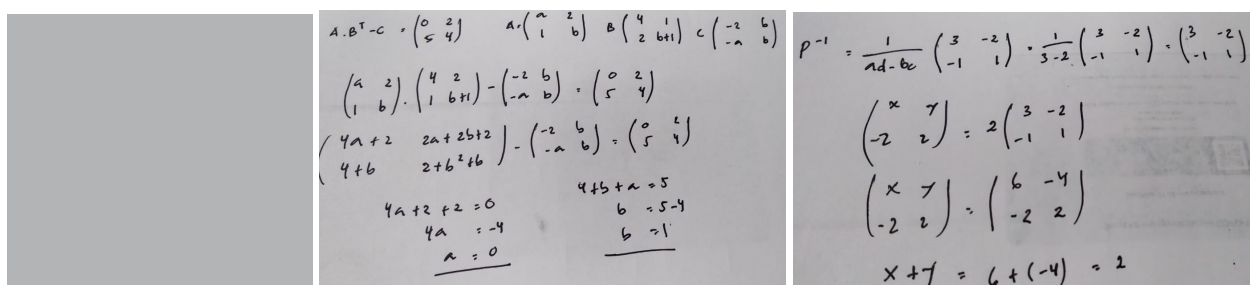


Figure 10. Work Results of Test 1 Question Number 3 (left), number 4 (middle), number 5 (right)

Figure 13 is the solution made by S2 for the problem in Figure 3 (left). S2 experience misconceptions with example in working on a matrix math problem. From question number 3, what is actually be asked is multiplication by giving an example of matrix A. The example is given by giving the elements in the matrix A that have the order 2x2. From this example, it will be multiplied by a known matrix for find the values of the elements of matrix A. The values of the elements of matrix A that will later be able to use to determine the result of the multiplication between the two. The results of working on S2 in question number four. From the stage of processing, S2 has been in accordance with the concept learned about the inverse matrix of the order 2x2. The problem given is to find values a and b from the known matrices A, B, and C. S2 can understand what is being asked, It's just that the calculations made an error. In finding the value of a determining the value of which should be -4 divided by 4 gives -1, S2 gives the result division of '0. Accuracy in the work is very necessary, especially in calculation problems such as well as mathematics. While in the calculation to find the value of b, S2 can solve correctly.

The value obtained from the results of the S2 work on question number 5 is correct. Systematic in the work done states that S2 begins to understand what must be done or concepts in inverses and determinants of matrices begin to be understood.

Table 5. Description of Test and Interview Results to Subject 2

No	Description	Problem faced by S1	Scaffolding shape which is given	S1's reaction to the scaffolding given
1	Process which done in S2 complete question number 1 wrong.	<ul style="list-style-type: none"> • S2 not yet understand draft multiplication of two matrices. It cannot found results from score multiplication two matrix. • Traits matrix multiplication yet mastered. 	Researchers provide explanation about multiplication properties correct matrix. There are traits owned by matrix on multiplication matrix. Among them that is Distributive: $A \times (B + C) = AXB + AXC$	After listening researcher explanation, S1 start to understand multiplication property of matrix, and start getting give solution.
2	Workmanship done S2 in complete question number 2 is wrong	<ul style="list-style-type: none"> • Multiplication on both sides who do not understand S2, so it doesn't work find the value of X 	Researchers provide explanation about second multiplication method segment for eliminate wrong one of the variables	Hear and pay attention to the display which has been given, S2 capable find the inverse obtained from wrong elimination one variable exists
3	S2 wrong in give problem solving number 3	<ul style="list-style-type: none"> • Give an example for a problem that not known number - the numbers. 	Give intermezzo to students with give parable	Recall material ever studied and try to solve the problem there is
4	Workmanship done S2 in complete question number 4 is wrong	<ul style="list-style-type: none"> • Less thorough in distribution which done for find the value of a. 	Give question "in find the value of a, you divide -4 with 4 returns 0?"	From the question that given by researcher, S2 direct realize that negligence in complete distribution.

Discussion

E-scaffolding is a term in the world of education in constructivist learning theory modern. *E-scaffolding* takes a very important role in the development of participant learning educate. Every time a student reaches a certain stage of development in learning, marked by the achievement of certain indicators, students will need *scaffolding* (Bikmaz et al., 2010). The form of implementing the e-scaffolding strategy in learning be done in stages according to the learning needs and level of thinking development of each participant educate. The results obtained in this study, the provision of *e-scaffolding* makes the subject more active in conveying ideas because the subject is able to explore concepts that have not been known in problem solving. And a more flexible time because it is not hindered by the existing time division is like face-to-face learning so that questions can be answered submitted can be answered and take place effectively. The understanding gained by each subject can be helped by the *e-scaffolding* provided by the researcher. Subjects can easily ask what the difficulties are in the process and use the internet as a reference to find materials and concepts that cannot understood. On the other hand, many subjects are lacking response by giving questions via online characters do not respond and pay less

attention we cannot handle. From these problems, educators still pay attention to be able to attracting the subject so that they can return to pay attention to what the teacher gave during the process learning

The application of *e-scaffolding* in learning mathematics creates interactive learning, subjects can be helped by the existence of e-scaffolding in the learning process. The provision of *e-scaffolding* will decrease if the competency of the subjects has been improved. Educators as learning facilitators are shown through the provision of *e-scaffolding*. Another advantage of e-scaffolding if done correctly will increase student achievement, increase confidence in interacting online, reduce stress and frustration levels from students who do not understand math subject matter, turn fear into motivation so they can do more, and motivate students. To be more active in learning mathematics without feeling bored and eliminating difficult mathematical mindsets or monsters from a science.

CONCLUSION

Based on the exposure of the research results, the provision of *e-scaffolding* to students is very important effective for the progress of students' understanding in understanding lessons, especially subjects mathematics (calculation). The character of students in the development of education can objectively visible, both from the cognitive, affective, and psychomotor domains.

The types of difficulties that students experience in solving matrix material problems; (1) understanding the problems that exist in the problem (2) solving problems, cannot use formulas and cannot perform calculation operations correctly; (3) not being careful with the results obtained, not re-checking the results of the work, (4) easy to give up with the process carried out. Giving e-scaffolding makes students more open to the difficulties they have. So that in solving problems they are not ashamed to ask where the misconceptions of the material studied are. *E-scaffolding* is provided according to the needs of each student. Researchers hope that in future research there will be the development of *e-scaffolding* that can provide conceptual understanding, have the ability to reason in solving existing problems, and have procedural skills.

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