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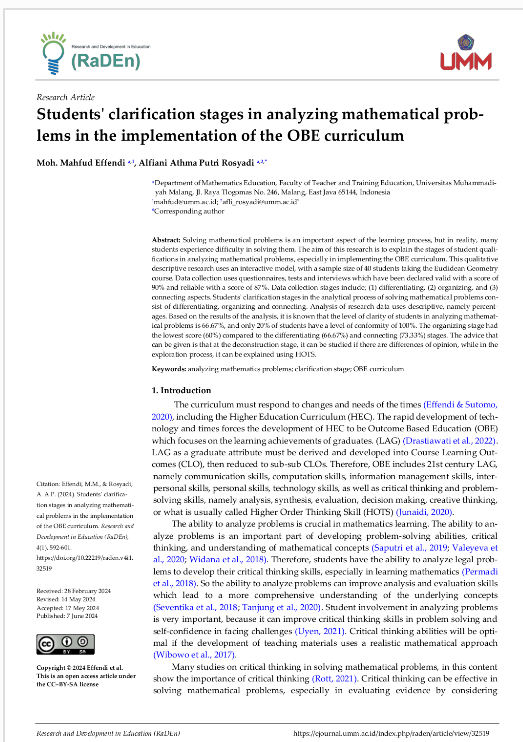

Research and Development in Education (RaDEn)
UMM

Research Article

Students' clarification stages in analyzing mathematical problems in the implementation of the OBE curriculum

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Abstract: Solving mathematical problems is an important aspect of the learning process, but in reality, many students experience difficulty in solving them. The aim of this research is to explain the stages of student qualifications in analyzing mathematical problems, especially in implementing the OBE curriculum. This qualitative descriptive research uses an interactive model, with a sample size of 40 students taking the Euclidean Geometry course. Data collection uses questionnaires, tests and interviews which have been declared valid with a score of 90% and reliable with a score of 87%. Data collection stages include; (1) differentiating, (2) organizing, and (3) connecting aspects. Students' clarification stages in the analytical process of solving mathematical problems consist of differentiating, organizing and connecting. Analysis of research data uses descriptive, namely percentages. Based on the results of the analysis, it is known that the level of clarity of students in analyzing mathematical problems is 66.67%, and only 20% of students have a level of conformity of 100%. The organizing stage had the lowest score (60%) compared to the differentiating (66.67%) and connecting (73.33%) stages. The advice that can be given is that at the deconstruction stage, it can be studied if there are differences of opinion, while in the exploration process, it can be explained using HOTS.

Keywords: analyzing mathematics problems; clarification stage; OBE curriculum

1. Introduction

The curriculum must respond to changes and needs of the times (Effendi & Sutomo, 2020), including the Higher Education Curriculum (HEC). The rapid development of technology and times forces the development of HEC to be Outcome Based Education (OBE) which focuses on the learning achievements of graduates. (LAG) (Drastiawati et al., 2022). LAG as a graduate attribute must be derived and developed into Course Learning Outcomes (CLO), then reduced to sub-sub CLOs. Therefore, OBE includes 21st century LAG, namely communication skills, computation skills, information management skills, interpersonal skills, personal skills, technology skills, as well as critical thinking and problem-solving skills, namely analysis, synthesis, evaluation, decision making, creative thinking, or what is usually called Higher Order Thinking Skill (HOTS) (Junaidi, 2020).

The ability to analyze problems is crucial in mathematics learning. The ability to analyze problems is an important part of developing problem-solving abilities, critical thinking, and understanding of mathematical concepts (Saputri et al., 2019; Valeyeva et al., 2020; Widana et al., 2018). Therefore, students have the ability to analyze legal problems to develop their critical thinking skills, especially in learning mathematics (Permadi et al., 2018). So the ability to analyze problems can improve analysis and evaluation skills which lead to a more comprehensive understanding of the underlying concepts (Seventika et al., 2018; Tanjung et al., 2020). Student involvement in analyzing problems is very important, because it can improve critical thinking skills in problem solving and self-confidence in facing challenges (Uyen, 2021). Critical thinking abilities will be optimal if the development of teaching materials uses a realistic mathematical approach (Wibowo et al., 2017).

Many studies on critical thinking in solving mathematical problems, in this content show the importance of critical thinking (Rott, 2021). Critical thinking can be effective in solving mathematical problems, especially in evaluating evidence by considering

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1. Introduction

The curriculum must respond to changes and needs of the times (Effendi & Sutomo, 2020), including the Higher Education Curriculum (HEC). The rapid development of technology and times forces the development of HEC to be Outcome Based Education (OBE) which focuses on the learning achievements of graduates. (LAG) (Drastiawati et al., 2022). LAG as a graduate attribute must be derived and developed into Course Learning Outcomes (CLO), then reduced to sub-sub CLOs. Therefore, OBE includes 21st century LAG, namely communication skills, computation skills, information management skills, interpersonal skills, personal skills, technology skills, as well as critical thinking and problem-solving skills, namely analysis, synthesis, evaluation, decision making, creative thinking, or what is usually called Higher Order Thinking Skill (HOTS) (Junaidi, 2020).

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Many studies on critical thinking in solving mathematical problems, in this content show the importance of critical thinking (Rott, 2021). Critical thinking can be effective in solving mathematical problems, especially in evaluating evidence by considering different perspectives (Rosyadi et al., 2022). Therefore, it is necessary to emphasize the importance of problem-based learning, especially in improving critical thinking skills and mathematical problem-solving abilities (Arwanto et al., 2019; Septriansyah et al., 2022). Apart from that, problem-based learning can encourage students to learn actively (Rahayuningsih et al., 2023; Wibowo et al., 2017). Critical thinking is an important aspect in the learning process, but the fact is that many students in Indonesia still have low critical thinking processes. Therefore, research is needed that can improve the critical thinking process. Analysis is one aspect of critical thinking that can be explored. By using clarification, it can make it easier for students to convey their ideas. The benefit for future research is that it can be used as a reference for compiling relevant instruments.

The process of analyzing problems is not easy, students still have difficulty solving problems in the form of HOTS-based story questions (Septriansyah et al., 2022). Difficulty in reading and understanding questions, transformation, processing, and coding. These difficulties hinder the analysis and solving of mathematical problems accurately (Isyam & Hidayati, 2022). The complexity of mathematical problems is a challenge, especially the complexity of questions (Rahayuningsih et al., 2023). Apart from that, the formulation and structure of mathematical problems also influence students' understanding and self-efficacy in solving mathematical problems. This indicates that the way mathematical problems are presented can influence students' ability to analyze and solve mathematical problems (Uyen, 2021). Based on this, the actual stage of analyzing a problem is in the critical thinking process (Relaford-Doyle & Núñez, 2021).

The process of analyzing problems is related to the clarification process. Analyzing a problem involves understanding its components, identifying relevant information, and formulating a resolution plan. In addition, the clarification process involves categorizing data into groups based on their characteristics or attributes (Arana & Stafford, 2023). In the context of mathematics learning, the ability to analyze and solve problems is very important for students' learning and cognitive development (Hidayah et al., 2020; Rott, 2021). Of course, the problem-based learning model can improve analytical and problem-solving skills, and allows students to be directly involved with real-life experiences and will be effective in overcoming problems (Rahayuningsih et al., 2023; Wibowo et al., 2017). In addition, critical thinking skills are an important element in problem solving, which allows students to understand problems, plan solutions, and carry out their plans effectively. Therefore, there is a connection between analytical thinking, problem solving, and critical thinking in dealing with problems (Rosyadi et al., 2022).

In analyzing mathematical problems, students still make mistakes, namely not being able to differentiate between what is appropriate and what is not appropriate to the problem, not being able to integrate and describe the concept to be solved, and not being able to determine the appropriate point of view in solving the problem. Therefore, studies are needed related to the clarification stages in analyzing mathematical problems, so the aim of this research is to explain the stages of student clarification in analyzing mathematical problems, especially in implementing the OBE curriculum. So that the problem does not become widespread, this research focuses on understanding the cognitive processes involved in students' clarification stages during mathematical problem solving. It is hoped that the results of this research will contribute to a broader understanding of the process of solving mathematical problems in the implementation of the OBE curriculum.

2. Methods

2.1. Research Approach

To answer the research objectives, a qualitative approach was used, with a case study type. A case study is a strategy in which researchers carefully investigate a program, event, activity, process or group of individuals in a particular place (Gerring, 2017; Sugiyono, 2020; Yin, 2016). The case study refers to the process of solving mathematical problems carried out by the subject. In this case, researchers explored this process to find out how students think critically when solving mathematical problems, especially in implementing the OBE curriculum.

2.2. Subjects

This research took place at the Mathematics Education Program, Faculty of Teacher Training and Education, Muhammadiyah University of Malang, and was carried out in the odd semester 2023/2024. The research subjects were 2022A class of 40 students who were taking the Algebraic Structure course and had taken the Euclidean Geometry course. Out of the 40 students, only 15 (37.5%) were observable and could be analyzed based on their proficiency in the clarification stages, including distinguishing, organizing, and connecting aspects. The selection of these subjects is based on the assumption that they are considered to have the prerequisite abilities that can be used in solving the given mathematical problems.

2.3. Data Collection and Instruments

Data was obtained using test, observation and interview techniques. Test techniques are used to obtain data on students' abilities in analyzing mathematical problems. The test consists of 4 descriptive questions, and has passed the validation process with a very good category. Clarification stages in solving mathematical problems, as in Table 1.

Table 1. Clarification indicators and descriptors in problem solving

Aspect	Indicators	Descriptors
Clarification	Establishing confidence in what is decided	State and write again whether the solution is correct
	Clarifying the results of his work	Recalculate the solution results

The results of validation by lecturers on the test instrument obtained a feasibility assessment of 87% with the criteria "very feasible", the results of validation of the interview instrument obtained a feasibility assessment of 90% with the criteria "very feasible".

The questions given to students are Algebraic Structure, and observations are made to ensure that the process of working on the questions independently, without collaborating, cheating, and so on. The following is the question in question.

Soal Tes:

1. *Jelaskan kapan suatu fungsi dikatakan bukan grup! Kaitkan dengan setiap konsep yang sudah Anda peroleh sebelumnya*
2. *Selidiki, apakah himpunan bilangan bulat yang ganjil terhadap operasi penjumlahan adalah grup?*
3. *Misalkan* $H = \{a, b, c, d\}$ *dengan operasi * adalah operai biner. Lengkapilah table Cayley berikut agar membentuk pola dari suatu grup dengan operasi * Jelaskan!*

*	*a*	*b*	*c*	*d*
a				
b				
c				
d				

4. *Tuliskan apa saja yang sudah Anda pelajari dalam satu semester ini. Sajikan keterkaitan materi yang sudah Anda pelajari dalam peta konsep!*

The results of student answers are in the form of analysis stages of the mathematical solutions above, corrected and confirmed through interviews. The aim is to determine and categorize the analysis stages of student answers into four categories, namely very suitable (VS), suitable (S), less suitable (LS), and very unsuitable (VUS), with intervals: $VS = 100; 66{,}66 \leq S < 100; 33{,}33 \leq LS < 66{,}66; 0 < VUS < 33{,}33$; dan 0 = not working/not clear about clarification stages. Meanwhile, the indicators and descriptors of the clarification stages are as in Table 2.

Table 2. Clarification stage in the analysis stage

No	Indicators	Descriptors
1.	A= Differentiating	Distinguish what is appropriate or important from what is irrelevant and unimportant from the material presented
2.	B= Organizing	Determine the appropriate and functional elements in structure
3.	C= Conecting	Determine the viewpoint, bias, values, or intent underlying the material provided

2.4. Data Analysis

To answer the stages of student clarification in analyzing mathematics problems, especially in implementing the OBE curriculum, qualitative descriptive analysis is used. Qualitative data analysis also takes place during data collection. Thus, the qualitative analysis model used in this research is an interactive model (Miles & Huberman, 2020), namely data collection, data reduction, data display, and conclusion/drawing/ verification. For data validity, triangulation is used, and the model presented in Figure 1.

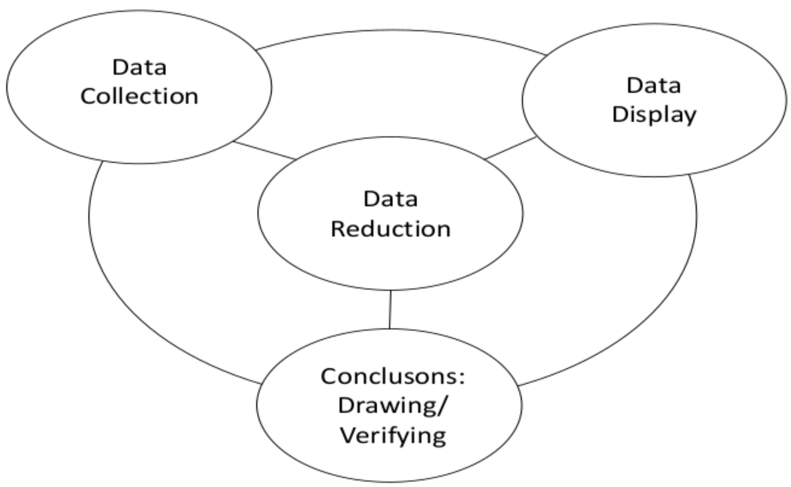

Figure 1. Interactive model analysis

3. Results

The main instrument of this research is a test. The development of this Algebraic Structure test must meet valid criteria, so that it can be used and obtain data that meets the research objectives. Based on the expert validation results, it was stated that the test instrument was very good, with the following description in Table 3.

Table 3. Description of test validation results

No	Aspect	Validator Score (%)			Average (%)	Category
		1	2	3		
1.	Purpose and construction	100	95	96	97	Very Good
2.	Content	98	95	95	96	Very Good
3.	Characteristic consistency	100	100	100	100	Very Good
4.	Relevance	100	100	100	100	Very Good
5.	Language	100	100	100	100	Very Good
6.	Instructions and format	99	98	99	98.7	Very Good
Average (%)		99.5	98	98.3	98.61	Very Good

There exist six aspects that have been validated, namely purpose and construction, content, consistency of characteristics, relevance, language, and intrusion and format (Brennan, Robert L., 2006; Banta, Trudy W., et.al., 2014). In general, the validity rate is observed to be quite satisfactory at 98.61% with no need for revision. However, out of the six aspects, the lowest validity rate is observed in the domain of content, which stands at 96%.

The Algebraic Structure test, whose validity has already been established, was administered to a group of 40 students. They were given a time frame of 3x50' to complete the test, while also utilizing their existing knowledge. In order to ensure accuracy, interviews were conducted to assess the students' understanding of the problem-solving stages in the test questions. Out of the 40 students, only 15 (37.5%) were observable and could be analyzed based on their proficiency in the clarification stages, including distinguishing, organizing, and connecting aspects (as shown in Table 2). The findings from the work of these 15 students can be summarized as follows (score 1=*VS* and *S*; score 0 = *LS* and *VUS*). Distribution of student clarification scores based on indicators, presented in Table 4.

Table 4. Distribution of student clarification scores based on indicators

No	Student	Indicator Scores			Total
		A	B	C	
1.	S1	1	0	0	1
2.	S2	1	1	1	3
3.	S3	1	1	1	3
4.	S4	1	0	1	2
5.	S5	1	1	1	3
6.	S6	1	0	1	2
7.	S7	0	1	0	1
8.	S8	0	1	1	2
9.	S9	1	1	0	2
10.	S10	0	1	1	2
11.	S11	1	0	1	2
12.	S12	1	1	0	2
13.	S13	0	0	1	1
14.	S14	1	0	1	2
15.	S15	0	1	1	2
Total		10	9	11	30
Average (%)		66.67	60	73.33	66.67

The level of suitability for students' clarification stages in analyzing mathematical problems was 66.67%, but only 20% of students had a suitability level of 100%. The level of suitability for the organizing aspect is 60%, this aspect is lower than the differentiating (66.67%) and connecting (73.33%) aspects. This shows that the ability to organize, namely determining how elements fit and function in the structure, is more difficult than: 1) the ability to distinguish what is appropriate or important from what is irrelevant and unimportant from the material presented, and 2) the ability to connecting, namely determining the point of view, bias, values, or intentions underlying the material presented. This illustrates that students are less capable or rarely carry out the clarification process.

Below, two students (subject 1 and subject 2) are taken as examples of experiencing the analysis process and carrying out the process of clarifying answers. Subject 1, in the differentiation process, checked again by proving the associative properties of the existing elements. In the organizing process, subject 1 can identify the right and wrong answers, but cannot check the results again to determine the point of view that can underlie the work process. Clarification stage of subject 1, presented in Figure 2.

a. Suatu grup dengan operasi *

*	a	b	c	d
a	b	a	d	c
b	a	b	c	d
c	d	c	b	a
d	c	d	a	b

1. Dari tabel cayley dapat dilihat bahwa $\forall x, y \in H$, maka $x * y \in H$ maka dapat dikatakan $(H, *)$ tertutup
2. Ambil sebarang $x, y, z \in H$, akan dibuktikan bahwa
   $(x * y) * z = x * (y * z)\ \forall x, y, z \in H$
   Perhatikan bahwa
   $(x * y) * z = (x * y * xy) * z$

$= (x * y * xy) * z * (x * y * xy)z$

$= x * y * xy * z * xz * yz * xyz$

$= x * (y * z * yz) * x(y * z * yz)$

$= x * (y * z * yz)$

Figure 2. Clarification stage of subject 1

Subject 2, in the differentiation process, also checked the results of his work again but there was a concept error that was made and he didn't know about it. In the organizing process, subject 2 can recalculate the appropriate answers, but cannot recalculate from the results to determine the perspective of completing the test. Clarification stage of subject 2, presented in Figure 3.

a. Suatu grup dengan operasi *
Tabel Cayley

*	a	b	c	d
a	a	b	c	d
b	b	a	d	c
c	c	d	b	a
d	d	c	a	b

1) Dari tabel Cayley dapat dilihat bahwa $\forall x, y \in H,\ maka\ x * y \in H$
2) Asosiatif, $H \subseteq R\ dan\ R\ berlaku\ asosiatif\ maka\ H\ juga\ berlaku\ sifat\ asosiatif,$ karena

$$(a * b) * c = a * (b * c)$$

$$b * c = a * d$$

$$d = d$$

3) a adalah unsur identitas dari H terhadap operasi *, karena
   $a * a = a = a * ab * a = b = a * bc * a = c = a * cd * a = d = a * d$

4) H terhadap operasi * punya invers, karena

$a^{-1} = a, \quad a * a = ab^{-1} = b, \quad b * b = ac^{-1} = d, \quad c * d = ad^{-1} = c, \quad d * c = a$

Karena memenuhi semua syarat, maka $(H, *)$merupakan grup

Figure 3. Clarification stage of subject 2

4. Discussion

The results of this research are very relevant to efforts to optimize CLO achievement in the OBE curriculum (Junaidi, 2020), because they directly discuss students' critical thinking skills and clarifying analysis (Wibowo et al, 2017). Outcome Based Education (OBE) is a curriculum that refers to the outcome. So that not only the material that must be applied in the classroom, but also prepare how graduates (outcomes) who have been equipped with the ability to face the world of work. The advantage of learning that focuses on critical thinking, especially the clarification process using the OBE curriculum is that it can maximize the potential of students so that they can apply the concepts received to society. In addition, students can apply it in their daily lives. The clarification stage in analyzing mathematical problems can encourage students to be more active and able to think critically, especially in providing simpler explanations (Altun & Konyalioglu, 2019; Yuan & Stapleton, 2020; Wibowo et al, 2017). Effendi & Sitompul (2023) stated that analysis of the clarification stages in the process of solving mathematical problems can develop critical thinking skills and clarifying analysis. This research certainly gives hope that problem-based learning innovation can encourage students to be more active and able to think critically, especially in the context of mathematics learning.

Many studies state that the problem-based learning model influences mathematics learning outcomes, especially in terms of critical thinking skills (Ulger, 2018). This also means that critical thinking skills influence mathematics learning outcomes. Bregant (2014) even stated that the association between critical mathematical thinking skills, communication, and an attitude of curiosity is the impact of problem-based learning. Critical thinking skills have a very important role in the process of analyzing mathematical problems. This ability not only influences mathematics learning outcomes, but also encourages active learning, and having a high curiosity attitude in learning mathematics (Tanjung et al., 2020). Therefore, developing critical thinking skills through problem-based learning methods can significantly improve understanding and learning outcomes in mathematics (Rosyadi et al., 2021). Of course, a deep understanding of the importance of critical thinking skills in the process of analyzing mathematical problems provides a strong foundation for developing learning strategies that support the development of critical thinking skills in the context of mathematics learning (Rosyadi et al. 2022).

Problem-based learning as a learning method also determines students' abilities, and this was stated by Arwanto et al., (2019), regarding the importance of critical thinking skills in the process of analyzing mathematical problems. This opinion explores how different learning methods and values affect students' clarifying analysis and critical thinking skills in problem solving analysis. It can be used to highlight the importance of cultivating critical thinking skills to improve mathematical problem-solving analytical abilities

The relationship between HOTS and critical thinking skills is very strong (Effendi & Sitompul, 2023). Therefore, critical thinking skills are very important in solving mathematical problems that require high-level thinking (Arisoy & Aybek, 2021). Of course, problem-based learning methods can determine mathematics learning outcomes, especially in terms of critical thinking (EL-Shaer & Gaber, 2014). However, there is no significant interaction between learning methods and type of intelligence on the development of critical thinking abilities. Critical thinking skills in solving mathematical problems involve or require the ability to analyze, evaluate and conclude the right solution. Critical thinking disposition for prospective mathematics teachers, especially in designing cognitive and psychomotor assessment instruments (Setiawan et al., 2022; Arisoy & Aybek, 2021). Critical thinking dispositions, such as clarity in determining and applying criteria, as well as focusing on the main problem, are very important in the process of analyzing mathematical problems. The analysis process actually discusses the flow of analytical thinking in solving problems (Yuan & Stapleton, 2020). Therefore, critical thinking skills guide the flow of thought in solving mathematical problems, especially non-routine mathematical problems.

5. Conclusions

The clarification stage in analyzing mathematical problems is important and decisive, especially in implementing the OBE curriculum. The student clarification stages in the analysis process of solving mathematical problems consist of distinguishing, organizing, and connecting. In the differentiation process, students classify concepts that are appropriate and not appropriate to the problem. At the organizing stage, there is a process of determining elements that are appropriate and used in solving problems. So, the suggestion that can be made is that at the deconstruction stage, it can be explored when there are differences of opinion, while the exploration process can be analyzed using HOTS.

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Conflicts of Interest: We declare that there are no conflicts of interest

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