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The Implementation of an A-P-O Framework-Oriented Approach Using Worksheets in Algebra Lessons to Enhance Students Conceptual Understanding

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Abstract

This research aims to (1) increase students understanding of mathematical concepts in learning Algebra material using the application of an approach oriented to the A-P-O framework by using worksheets, (2) to find out the application of the approach oriented to the A-P-O framework by using worksheets optimally, and (3) describes the level of response in the implementation of learning. This research involved 34 students. This type of research is classroom action research which is carried out in 3 cycles. The action is an approach oriented to the A-P-O framework using worksheet. Research data was collected using tests and questionnaires. Next, the data collected was analyzed using narrative statistics which will result in the research sharing that; (1) understanding of concepts in learning Algebra material is higher as long as understanding is less than good. This can be seen from the fact that the percentage of students who are classified as having a minimum level of understanding is quite good from cycle I, cycle II and cycle III, each meaning 76.45%; 82.34% and 88.22%, (2) application of an approach oriented to the A-P-O framework using optimal worksheets is by providing guidance or direction to students to dare to work and express ideas in their minds to create their own mathematical concepts; train students to present their work; creating an atmosphere so that students are able to interact in learning, (3) student responses in cycle I are quite positive while cycle II and cycle III are classified as positive.

Keywords: A-P-O Framework; Understanding of Concepts

Introduction

In the future, students must have mastery of mathematics subject matter because mathematics plays an important role in everyday life. Apart from that, Mathematics serves as a vehicle for exploring other subjects both at the same level of education and at higher levels of education. In fact, mathematics plays a very important role in everyday life because mathematics contains several noble values. Mathematics has simple values, disciplinary values and cultural values. Mathematics has an easy value, namely mathematics is very useful in solving everyday dilemmas, for example those involving trade. The value of discipline in mathematics means that mathematics is an exact, correct science and always goes straight to the target, therefore it can foster discipline in the soul. Meanwhile, in terms of cultural values, it is said that cultural development (especially science and technology) cannot be separated from the role of mathematics.

Seeing how important mathematics is, it is hoped that understanding of concepts in mathematics learning can improve better. If we look further at students' understanding of concepts at school, especially understanding of mathematical concepts, it turns out that the results are still low. Based on the researcher's interviews with teachers, information was obtained that students' mathematics learning achievements in the last three years had not achieved the expected results in accordance with curriculum demands (Pradnyana & Sudarsana, 2024). This can be seen from the average student score, learning completeness and student absorption capacity can be seen in table 1.

Table 1. Student Learning Achievement Data

No	School year	Average	Completeness of Learning	Level of comprehension
1	2020/2021	6,1	67%	61%
2	2021/2022	5,8	66%	58%
3	2022/2023	6,0	68%	60%

(Source: List of Student Grades)

The problem expressed by class VII teachers in teaching mathematics, especially Algebra material, is that students' understanding of the material being taught is still lacking. Mathematics learning carried out so far uses the lecture method and is interspersed with giving model questions. The learning carried out very rarely helps students to be able to make correlations between the knowledge they already have and the material studied, so that students tend to memorize formulas or concepts produced in class learning (Kemmis, & Taggart, 988). Teachers mostly use models found in books or made on the blackboard without paying attention to whether the method used is in sync with the students' situation or not, so that students find it difficult to understand mathematical concepts which results in students not learning with understanding.

Students feel that they do not understand the relationship between the material being studied, this is because they forget relevant previous material. Although this fact cannot be used as an indicator of the quality of education, it is sufficient to provide an illustration of students' lack of success in learning. In today's education system, the selection and use of teaching methods is more directed towards student innovation and creativity in the process of teaching and learning activities (Artawijaya & Saptiari, 2023). This is based on a perception that students are learning subjects who have potentials that can be developed. Bruner (1966) in his theory learning mathematics will be more successful if the teaching process is directed at the concepts and structures contained in the subject being taught in addition to the related relationships between concepts and structures. This is where the existence of a teacher is required to be clever in choosing the right method. The approach that can be used is one that can increase understanding of concepts by constructing one's own knowledge. This learning approach allows students to be mentally active in learning Mathematics. The learning approach in question is oriented towards constructivist learning. One form of learning with a constructivist perspective is the A-P-O framework, this framework was put forward by Dubinsky Hudojo (2000) that students learn if they construct mathematical concepts or principles. The alternative that would like to be implemented is the application of an approach oriented to the A-P-O framework using worksheet. The aim is to increase students' understanding of concepts in learning Algebra material.

The question that often arises in global education is How do students gain knowledge? This question raises various versions of answers for education experts. One answer comes from realists who say that knowledge is an imitation or reflection of reality in thought. This means that this knowledge can be transferred completely from the teacher's mind to the learner's mind. As a result, in concept learning the teacher focuses on an effort to pour knowledge into the learner's head (Nurkancana & Sunartana, 1992). This has caused various kinds of failures in education. Events that have recently received widespread attention are constructivist views. The constructivist approach is in many ways very different from the behaviorist approach in giving meaning to learning. The behavioristic approach comes from objective theory which assumes that knowledge is

obtained by humans independently of individual experience and the learning process involves the acquisition of information. Constructivism was defined by Piaget as a way of expressing how humans arrive at their knowledge. Based on the results of his research on how children acquire knowledge, Piaget concluded that knowledge is built within children (Dahar, 1988). Piaget also stated that knowledge is constructed as a result of the learner's hard efforts to organize his or her experiences into schemas or cognitive structures that pre-exist within the child. The definition of constructivist learning theory is a learning theory that prioritizes the activity of creating and building on something that already exists studied. Building (constructive) activities can encourage students to always be active, so that their intelligence will also be higher (Bodner, 1986).

The circulation of constructivism holds the view that learning is the result of students' construction of their learning experiences (Erman, 2003; Nur & Wikandari, 1998). Likewise, what is hoped by thematic learning is that students can form their own knowledge after being directly and actively involved in their learning. Thus, it can be interpreted that learning is a process of actively forming meaning by the learner himself regarding new sensory input based on previously owned cognitive structures (Suparno, 1997). Some of the characteristics and principles of constructivist learning are:

1. Knowledge only exists in the human mind
2. Students build their own knowledge based on their experiences
3. Constructivist learning allows students to find the competencies, knowledge or technology they need to share themselves
4. Constructivist learning emphasizes students active involvement in the construction of meaning and knowledge

Several stages in constructivist learning are:

1. Introduce related figures or figures using subject
2. Formulate the benefits and objectives of the material to be studied
3. Provide feedback by freeing students to explore
4. Directing and guiding students as they learn.

Several disadvantages of constructivist learning theory mean, (1) It is difficult to change teachers' structured beliefs (2) teachers must have creativity in planning lessons (3) students and parents need time to follow the situation using a process learn and teach new things. Mathematics learning that builds its own concepts is helping students to create mathematical concepts using their own abilities through an internalization process as a result of which the concept is rebuilt, transforming the information obtained into new concepts or principles (Soejono, 1983). The constructivist view states that when investigating mathematics, students are directed to be able to create knowledge in their minds and connect/relate new information using their experiences in global discourse through a logical framework that transforms their experiences. Hudojo (1998) states that mathematics students who use a constructivist view are characterized by:

1. Students are actively involved in their learning;
2. new news must be linked to other news so that it is integrated using the schemata that students have so that understanding of information is complex; as well as
3. Learning orientation means solving dilemmas.

As a result of the constructivist view on mathematics learning, teachers will act as facilitators and intermediaries. so that students are formed new concepts through assimilation or accommodation, then the concepts that will be given are adjusted to the conceptions that the student already has. It has long been a topic of discussion and even the pros and cons between mathematics educators, mathematicians and mathematics observers in teaching mathematics. Zazkis & Campbell (1996) states learning mathematics is meaningful learning, meaning that every concept studied must be truly

understood before reaching the memorization stage. What teachers can do is provide opportunities for students to work on practice questions, so that students can create their own knowledge. Students are encouraged to be actively involved in learning so that concepts or principles can be constructed in students' minds. But what stands out in front of the class is the teacher's mastery. the teacher speaks while the students listen and take notes including questions and answers between the teacher and students.

Example questions are given and then students work on the questions. The teacher teaches the contents of the former book page by page. Success in teaching mathematics should not be viewed as a subject to be remembered only during exams or tests. It seems that to teach mathematics, a learning theory is needed that underlies how mathematics should be taught. The learning theory proposed here is an alternative, including that students learn if students construct mathematical concepts or principles Richey, Klein, & Tracey (2011) states a framework that provides the opportunity to construct mathematical concepts or principles in students' minds means the A-P-O series. The action in question is physical or mental manipulation that transforms objects using some method, in this case students think about or compare existing objects in their own way so that they can be accepted by the student's mind (Russefendi, 1979).

If the total action can occupy its entirety in the student's mind or can only be imagined without requiring all the special steps, the action has been included in the process. The process is something that arises from action, that is, if the objects observed or studied can be analyzed according to the student's mind, can be understood in their own language without requiring outside help. New processes can also be constructed using coordinating existing processes (Pramasanti, 2024). If it is a process itself to be transformed by an action, then we say that the process has been encapsulated (made into one) into an object, in other words an object is a formation of processes that become one by using an action, namely a coordination new processes become a process in themselves.

To produce an understanding of material, it is hoped that a learning pattern will be able to share students' intelligence effectively without memorizing the concept. This focus is intended so that students do not quickly forget the concepts they have learned, the most important thing is to make students learn naturally and quickly understand these concepts. for helping understand the concept of Algebra material, so the learning pattern that should be adopted in the learning process means a learning pattern that is able to share effective thinking skills with an emphasis on the quality of thinking (Sugihartono, 2013). This emphasis is expected because this quality of intelligence is increasingly needed by the world today. In understanding the concept created, words such as model, criteria or characteristics are repeatedly used to describe categorized activities and understanding the concept. These words have specific meanings and functions in all forms of learning about concepts, especially understanding concepts. a concept has five elements and a person is said to know a concept if he knows all the elements of that concept. These five elements are: a. name, b. examples, both positive and negative, c. characteristics, both main and not, range of characteristics, d. rules.

When learning Mathematics at school, students should be actively involved both mentally and physically. Active student work can be effective if the organization and delivery of material is appropriate using the students' mental readiness. Knowledge consists of past constructions or experiences about the world of objects built by viewing them through a logical framework by transforming, organizing and interpreting these experiences. According to the opinion above, knowledge cannot be transferred exclusively from the teacher's mind to the student's mind (Sa'diyah, Sutejo, & Daniar, 2024). Students do not just accept the mathematical concepts or principles taught because previously students already had something in mind.

This means that learning mathematics here is about using mathematical concepts that have been organized in students' minds so that they can be used to produce new concepts to be studied. So in learning, students must understand what they are learning. Learning from a constructivist view is helping students to create mathematical concepts with their own abilities through an internalization process as a result of which the concept is rebuilt, transforming the information obtained into new concepts or principles (Gita, 2000). A framework proposed by Dubinsky in constructing mathematical concepts or principles in students' minds is the A-P-O framework. The A-P-O framework means the framework. The A-P-O framework is a logical framework based on a constructivist view that provides the opportunity to construct mathematical concepts or principles in the minds of students (Dubinsky in Zaskis & Campbell, 1996).

The application of the A P-O framework is outlined in the form of worksheets, students work on practice questions on worksheets. The questions on the job card have been arranged based on the A-P-O framework. Students are guided to work on the questions on the worksheets little by little. The delivery method using worksheets can make it easier for students to learn mathematical concepts, because with worksheets mathematical concepts are studied in a series of instructions, statements and exercises which are arranged on the cards systematically and by using worksheets the learning atmosphere in the classroom becomes more interesting, not boring. As a result, it encourages students to concentrate more on learning.

Method

The type of research carried out is action research. The action taken was to apply an approach oriented to the A-P-O framework using paper cards in learning Algebra material. This research involved 34 students. This classroom action research was carried out in 3 cycles and each cycle referred to several sub-materials. Each cycle in this research consists of four stages, namely planning, application of action, assessment and observation and reflection.

1. Early Reflections

The initial situation regarding understanding of concepts and students' responses was obtained from exclusive interviews with teachers. From interviews it was discovered that students' conceptual understanding was still lacking, with average scores and students' learning completeness being 6.3 and 68%. Rumors came from teachers stating that the average score in Algebra material was the lowest compared to other materials. Students' understanding of concepts based on the teacher's original issues is still lacking because of the pattern used by the lecture method and spread with providing example questions, as a result in learning students tend to take notes on the material and have very little opportunity to build their own concepts from the material they study.

In this case, students learn without understanding, as a result they quickly forget to use relevant previous material. The actions carried out in this research were carried out in three cycles with stages: planning, action application, observation/assessment and reflection. The materials for each cycle are:

cycle I: a. Understanding whole numbers
b. Operation in whole numbers
cycle II: a. Multiples of a whole number
b. Least common multiple (KPK)
c. Factor A whole number
cycle III: a. Greatest Common Divisor (FPB)
b. Prime numbers and Prime Factors
c. Choose KPK and FPB from two numbers using factoring

2. Cycle

a. Planning Stage

Based on the results of the initial reflection, the researcher and class teacher prepared everything in collaboration using the research application, namely:

1) Design strategies to be used in learning together with practitioners.
2) Prepare worksheets prepared using the A-P-O framework.
3) Develop tests to determine students' understanding of concepts
4) Prepare a questionnaire to determine student responses to learning.

b. Action Application Stage

Cycle I, the actions taken were divided into 3 meetings. At the first meeting, learning was carried out on Understanding Algebraic Forms using tools in the form of worksheets with general activities such as:

1) Classically the teacher holds questions and answers about the material that has been studied previously
2) The teacher makes corrections/straightens out if students experience errors in remembering previous material.
3) The teacher conveys an apperception of the material that will be discussed in general using the question and answer method.
4) The teacher provides opportunities for students to communicate ideas or questions about the subject matter to be studied through discussion.
5) The teacher distributes worksheets individually for each student to work on.

The material in the work card is in the form of practice questions that have been prepared based on the A-P-O framework.

1) a). At the Action stage, students think about or compare existing objects in their own way so that they can be accepted by the student's mind.
2) b). If the objects observed or studied can be analyzed according to the student's mind, can be understood in their own language without requiring outside help, then it can be said that action has become a process. At this stage the transformation of objects can be accepted, understood or imagined by itself without special steps by the student, it can be said that the action can occupy the student's entire mind.
3) c). When the new processes can be coordinated into a process of its own or existing processes formed into one using an action then the process has become an object.
    a) The teacher determines the length of time to work on the questions on the work card
    b) While students are working on worksheets, the teacher supervises and encourages students to dare to express their thoughts.
    c) After the time specified for working on the questions on the work card is up, the assignment is classically discussed by randomly appointing students to present the results of their work verbally and ask questions.
    d) The teacher and students create a summary of the material or concepts that must be understood
    e) The teacher gives assignments individually or in groups. At the second meeting, learning is carried out, namely Algebraic Calculation Operations.

Learning steps:

1) The teacher and students discuss the assignments given to students in the first rendezvous
2) The teacher holds a question-and-answer session regarding the material studied at the first meeting.

3) The teacher conveys an apperception about the material that will be discussed in outline using the question-and-answer method.
4) The teacher gives students the opportunity to communicate ideas or questions about the subject matter to be studied. 5. The teacher distributes worksheets which have been prepared based on the A-P-O framework and determines the length of time to work on the questions on the worksheets.
5) The teacher supervises students while working on worksheets
6) After the time allocated for working on the questions on the work card is up, the task is systematically discussed by randomly leading students to present what will happen in their work verbally and using questions and answers.
7) The teacher and students produce a summary of the material that must be understood.

At the third meeting, students are given a test to determine students' understanding of the concepts that have been taught.

1) Observation and evaluation

Observation activities are carried out during the learning process by observing the learning situation in a general way and at the end of the learning the students are given a questionnaire to find out the students' responses. Assessment is carried out by delivering tests that are appropriate to the material being taught. The results of observations and student learning outcomes are used as a guide for assessing the actions that have been taken to determine the accuracy of the mechanism for implementing the actions.

2) Reflection

Based on the results of observations and evaluations, reflection is carried out at the end of the cycle with the aim of seeing the consequences of actions and improving the actions taken so that optimal results can be obtained. This is done by observing and analyzing what will happen in the tests achieved in cycle I and as a basis for improving planning in cycle II, as well as analyzing the obstacles or difficulties experienced by students in cycle I. Cycle II is carried out using action steps that are generally done almost the same using the actions given in cycle I with some restoration. Data collection techniques and instruments for conceptual understanding data are carried out using tests given to students at the end of each cycle, carried out individually. Student response data was collected through a questionnaire containing 8 items. The data collected was analyzed narratively.

Results and Discussion

1. Data That Will Occur in Research In Cycle I

The number of students who are classified at the level of understanding is very good, good, relatively good, poor and very poor as shown in table 1.2

Table 2. Cycle I Student Understanding Level

	Very Good	Good	Enough	Not enough	Very not enough
The numbers of student	3	7	16	4	4
Percentage	8,82%	20,58%	47,05%	11,76%	11,76%

That 76.45% of students are classified as having at least a fairly good understanding. Student response data also provided quite positive responses.

2. Data From Research Results In Cycle II

The number of students classified at the level of understanding is very good, good, relatively good, poor and very poor as shown in table 1.3

Table 3. Cycle II Students' Understanding Level

	Very Good	Good	Enough	Not Enough	Very Not Enough
The numbers of student	2	11	16	2	4
Percentage	5,88%	32,35%	44,11%	5,88%	11,76%

That 76.45% of students are classified as having at least a fairly good understanding. Student response data also shows that responses are classified as positive.

3. Data From Research Results In Cycle III

The number of students classified at the level of understanding is very good, good, relatively good, poor and very poor as shown in table 1.4

Table 4. Cycle III Students' Understanding Level

	Very Good	Good	Enough	Not Enough	Very Not Enough
The numbers of student	4	2	24	1	3
Percentage	11,76%	5,88%	70,58%	2,94%	8,82%

That 88.22% of students are classified as having at least a fairly good understanding. Student response data also shows that responses are classified as positive. In presenting the results of this research, it was found that before the classroom action research the average student score was 6.3 with understanding of mathematical concepts still lacking and after the classroom research the average student score was 7.70 in cycle III with the level of students' understanding of mathematical concepts classified as the minimum is quite good at 88.22%. The average score of these students increased by 18.18% from before the action research. These results show that the average student score and conceptual understanding of mathematics after the classroom action research was more than (increased) before the classroom action research.

Figure 1. Before Students Start Learning, They Begin With Prayer
(Source: Documentation Ni Komang Taman, 2024)

Based on the data analysis above, students' understanding of Algebra concepts, especially Understanding Algebra during the first cycle, was quite good. This can be seen in the percentage of students classified as having at least a fairly good understanding of 76.45%. This result has not reached the target set, namely at least 85% of students have at least relatively good understanding. There are also several shortcomings in learning, namely: students are hesitant to do practice questions on worksheets, students are less straightforward/courageous in expressing ideas or questions and students unable to explain the results of his work. Student responses in cycle I were quite positive so that learning went relatively well.

Figure 2. Students Begin To Think Of Ideas To Build Concepts
(Source: Documentation Ni Komang Taman, 2024)

This can be seen from the homogeneous response scores of students in rendezvous I and rendezvous II, namely 24.36. This result has not yet reached the criteria that are considered optimal so it still needs to be improved, because there are still some students whose response is very less positive towards learning. Paying attention to the reflection that will occur on the application of actions in cycle I, it can be seen that there are various shortcomings in the learning process. Based on these shortcomings, researchers held discussions with practitioners to make improvements to perfect the implementation of actions in the next cycle. Weaknesses in the form of students being hesitant about doing the practice questions on the worksheets are followed up by providing guidance to students so they have the courage to try doing them.

Figure 3. Students Begin To Write And Present The Results Of Their Work
(Source: Documentation Ni Komang Taman, 2024)

Weaknesses in the form of students not being straightforward/courageous in expressing ideas or questions are followed up by giving encouragement and encouragement to students to play an active and natural role in learning. Weaknesses in the form of students not being able to explain what will happen in their work are followed up by training students to make presentations. The improvements carried out are needed to cover the deficiencies in cycle I to be implemented in the next cycle. The application of actions in cycle II which were improvements to actions from cycle I gave relatively good results. Providing action in cycle II was quite successful in increasing understanding of the concept. This can be seen from the percentage of students who are classified as having at least a relatively good understanding of 82.34%.

What will happen is that this has not yet reached the set target, but classically there has been an increase of 76.45% to 82.34% of students classified as having at least a fairly good understanding. As a result, there was an increase of 7.70% from the understanding in cycle I. Student responses in cycle II showed that the homogeneous average student response score in cycle II was 27.19. When compared using the homogeneous average student response scores in cycle I, there was an increase of 11.61%. Although this has increased, it still has not reached the research criteria that have been set, as a result, it still needs to be improved.

In general, the improvements that have occurred are very significant as they have been able to increase the results obtained from the previous cycle. Behind the success of this action, there are still visible deficiencies during the implementation of the action so that improvements still need to be made to obtain optimal results. Reviewing the results of reflection on the implementation in cycle II, it was seen that there was a lack of interaction between one student and another, where it was seen that students who had better understanding tended to only do practice questions on the worksheets they faced and were less willing to help their friends who were experiencing difficulties. The tendency is for students who have better understanding to sit side by side with students who have relatively the same understanding. This was followed up by holding discussions with practitioners to rearrange students' seating positions with dynamic learning interactions in order to achieve a better understanding of concepts. Implementation of actions in cycle III, which is a restoration of actions from cycle II, provides results in accordance with the specified criteria. Data analysis of concept understanding and student responses provided a relatively good improvement. Students' understanding of Algebra concepts is relatively good. Based on reflection on the action application process in cycle III, the deficiencies found in the previous cycle could be covered and the results obtained were optimal based on the established criteria, although there were still some that could not be covered perfectly.

The obstacles experienced during the administration of action in this research included, (1) Students were still hesitant and slow in working on the practice questions on the work card, (2) Students are less direct/courageous in expressing ideas or questions, (3) Students are less able to explain the results of their work, (4) Students interact less with their friends, namely students who have better understanding tend to be side by side with students who have relatively the same understanding, By following up on the obstacles experienced, an A P-O framework-oriented approach can be implemented using optimal worksheets.

Conclusion

Based on the results of data analysis and discussion of research results, it can be concluded that: Class VII B students of SMP Negeri 1 Semarapura's understanding of the concept of Algebra by applying an approach oriented to the A P-O framework using

worksheets in the learning process is at a fairly good level of understanding. This can be seen from the percentage of students who are classified as having a minimum level of understanding that is quite good from cycle I, cycle II to cycle III, respectively 76.45%; 82.34% and 88.22%. In this research, it was found that before the classroom action research, the average student score was 7.70. This result has increased by 18.18% from before the classroom action research which was less than 85% and after the classroom action research the level of understanding was obtained at more than 85%. This means that there is an increase in students' understanding of mathematical concepts. Implementation of an approach oriented to the A-P-O framework using worksheets that provides optimal results is an implementation carried out using the following steps. a. The teacher provides guidance/direction so that students build it themselves mathematical concepts being studied in his own mind. b. Teachers train students to dare to express ideas or questions by providing encouragement and encouragement to play an active role in learning. c. The teacher trains students to present their work d. The teacher tries to create an atmosphere so that there is interaction between students and their friends in discussions on working on worksheets.

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