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IMPLEMENTATION OF REACT STRATEGY TO DEVELOP MATHEMATICAL REPRESENTATION, REASONING, AND DISPOSITION ABILITY

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Abstract

The purpose of this study was to describe how to implement the REACT strategy to develop students' mathematical representation, reasoning, and disposition ability. This research was a descriptive study with a qualitative approach. The subject of this study was grade 8 junior high school student in Bandung. Data collection techniques in this study with observations, interviews, and documentation. Based on data analysis results, it could be concluded that REACT strategies can be applied to develop a mathematical representation, reasoning, and disposition ability that engages students actively. Implementation of the REACT strategy runs smoothly and gets enthusiastic responses from students. The application of REACT strategies should be undertaken sustainably so that the learning objectives can be achieved by integrating various mathematical skills that were capable.

Keywords: REACT Strategy, Mathematical Representation, Reasoning, Disposition Ability.

Abstrak

Tujuan penelitian ini adalah untuk mendeskripsikan bagaimana implementasi strategi REACT dalam mengembangkan kemampuan representasi, penalaran, dan disposisi matematis. Penelitian ini adalah penelitian deskriptif dengan pendekatan kualitatif. Subjek penelitian adalah siswa SMP kelas VIII di Bandung. Teknik pemilihan subjek penelitian ini menggunakan teknik purposive sampling. Teknik pengumpulan data dalam penelitian ini dengan observasi, wawancara, dan dokumentasi. Berdasarkan hasil analisis data, dapat disimpulkan bahwa strategi REACT dapat diterapkan untuk mengembangkan kemampuan representasi, penalaran, dan disposisi matematis yang melibatkan siswa secara aktif. Implementasi strategi REACT berjalan dengan lancar dan mendapatkan respons antusias dari siswa. Penerapan strategi REACT hendaknya dilakukan secara berkelanjutan agar tujuan pembelajaran dapat tercapai dengan mengintegrasikan berbagai kemampuan matematis yang mumpuni.

Kata kunci: Strategi REACT, Kemampuan Representasi, Penalaran, Disposisi Matematis.

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Mathematics is one of the sciences that can improve the ability to think, argue, communicate, and contribute to solving daily problems and the world of work, as well as the development of science and technology (Sari & Mahendra, 2017; Muhtadi, et al. 2018; Kenedi, et al. 2019; Genc & Erbas, 2019). An understanding of mathematics prepares students to be able to survive in changing and competitive conditions in the future.

However, mathematics has a public image as a difficult, tedious lesson, and can only be accessed by a few people (Atallah, Bryant, & Dada, 2010; Laurens, Batlolona, Batlolona, & Leasa, 2018; Larkin & Jorgensen, 2016). It's because mathematics contains many abstract concepts (Mumu, Prahmana, & Tanujaya, 2017; Dreyfus, 2002). In general, learning in Indonesia only emphasizes memorization and is not accompanied by deep understanding that can be applied in real situation (Muslich, 2007; Nuari, et al. 2019). Besides that, generally the learning method used is conventional learning, without any variation in learning. So, students are passive in the learning process. As a result, students' mathematical abilities are of low quality. It can be seen from the achievements of mathematical literacy in the Programme for International Student Assessment (PISA). The PISA 2018 results, Indonesian students scored lower than the OECD average in mathematics (OECD, 2019).

PISA questions use non-routine problems that very often involve object representation and mathematical situations (OECD, 2014) and test high reasoning abilities. Based on the results of the PISA 2012 on mathematical representation and reasoning, it is illustrated that the ability of Indonesian students is still weak in both abilities. In fact, these abilities are interrelated and have become the goal of education in Indonesia.

Mathematical representation ability is the ability to restate a problem or mathematical object through things such as: selecting, interpreting, translating, and using graphics, tables, images, diagrams, formulas, equations, and concrete objects to express problems so that they are more clear (OECD, 2003). Representation does not only refer to the results or new construction products, but involves the process of thinking that is done to capture and understand the concept. In other words, mathematical representation ability is used as a reasoning tool to express mathematical concepts and ideas. Reasoning in mathematics can develop and reveal one's views about a problem. Reasoning is logical thinking that uses both induction and deduction techniques to get conclusions (Santrock, 2010).

Learning mathematics is also intended to develop affective domains such as mathematical disposition (Almerino, et al. 2019). Mathematical disposition is related to student attitudes that are flexible, confident, persistent in facing mathematical challenges and problems, enjoying mathematics, having high curiosity in learning mathematics, and appreciating the beauty of mathematics (Polking, 2019). Thus, fostering students' mathematical disposition is no less important than efforts to improve mathematical representation and reasoning ability.

Recognizing the importance of the mathematical representation, reasoning, and disposition ability in learning mathematics, it is necessary to use learning strategies that can provide opportunity and encourage students to practice these abilities. One of several learning strategies that can be applied in mathematics learning is REACT strategy. Where, REACT strategy is teaching based on contextual learning strategies arranged to encourage student involvement in the classroom (CORD, 2019). REACT is an acronym of Relating, Experiencing, Applying, Cooperating, and Transferring (Sari, Darhim, & Rosjanuardi, 2018). Learning with REACT strategies will provide many learning experiences to students because learning is more interpreted as learning throughout of life; students learn by actively exploring the information and technology needed, both individually and in groups to build knowledge; students not only master the contents of their subjects but they also learn how to learn (Crawford, 2001). REACT strategy can be used by teachers to practice students' mathematical representation and reasoning ability. According to the Center for Occupational Research and Development or CORD (2019), students enrich the basic understanding of the concept of Learning with hands-on activity (experiencing). Representation should be seen as an important element to (1) support students' mathematical understanding and reasoning, and understanding of relationships (NCTM, 2000). Then, students need confidence and persistence in facing every problem given in the learning process (CORD, 2019). It must always be maintained and developed through the creation of a learning atmosphere that interests students and tends to be challenging to explore. The REACT strategy is designed to foster students' mathematical dispositions.

Based on several studies, it is stated that REACT strategy have an influence and increase understanding of students' mathematical concepts (Novri, Zulfah, & Astuti, 2018; Anas & A, 2018; Junedi & Ayu, 2018). In another study showed REACT strategy was more effective than conventional learning from aspects of mathematics learning achievement, problem solving ability, connection ability, self efficacy, and motivation (Putri & Santosa, 2015; Safitri & Mahmudi, 2017). The study result showed that there was an increase in students' mathematical understanding and representation ability in learning with REACT strategy (Wulandari, Praja, & Aminah, 2018). Thus, the purpose of this study was to describe how to implementation REACT strategy to develop mathematical representation, reasoning, and disposition ability.

METHOD

This study was conducted as an effort to describe how to implementation REACT strategy to develop mathematical representation, reasoning, and disposition ability of junior high school students. This research is a descriptive study with a qualitative approach. The subject of this study were grade 8 junior high school students in Bandung. The technique sampling of this study was using a purposive technique sampling. The subject of this study obtained learning with REACT strategy. In this study, researchers play a direct role as a teacher in the learning process.

Data collection techniques in this study are by observation, interview and documentation. Observation is carried out during learning. The observation sheet is used to observe situations that occur during the learning process and are prepared based on the characteristics of REACT strategy. The characteristics of REACT strategy were Relating, Experiencing, Applying, Cooperating, and Transferring. The observation sheet is filled by observers. This observation sheet is in the form of observations about the course of ongoing learning, so that it can be evaluated and know what aspects must be improved. Interview is conducted to determine the difficulties experienced by students during the learning process. Furthermore, documentation is done with video recording while learning takes place. Learning tools is used in this study include syllabus, lesson plan, hand out, and student worksheets. Learning activities are designed with REACT strategy learning steps, so students can build their knowledge. Learning tools are emphasized to develop students' mathematical representation, reasoning, and disposition ability. In addition, the main material in this study is 3 dimentional shape.

RESULTS AND DISCUSSION

REACT strategy includes activities relating, experiencing, applying, cooperating, and transferring (CORD, 2019; Harwell, 2003; Crawford, 2001). Implementation of REACT strategy designed to foster mathematical representation, reasoning, and disposition runs smoothly and gets enthusiastic responses from students. It could be seen from the activity of students in every learning activity in the classroom. The activeness of students in the classroom could be seen from high motivation in learning, activeness of students in group discussions, asking the teacher, students are more enthusiastic when learning such as working on the questions on the board.

Related activities are carried out at the beginning of learning where the teacher asks questions that can be answered by almost all students from life experiences or knowledge that they already have (Crawford, 2001; CORD, 2019; Harwell, 2003). In this activity, the teacher can design responsive experiences and learning in building students' knowledge with familiar things, thus forming a deeper understanding. When the questions posed by the teacher can be answered by almost all students. It can be a motivation, interest, and lead to strong self-confidence for students at the beginning of learning (Furner & Berman, 2005).

In relating activities, the teacher provides an illustration of the concept of 3 Dimentional shape with a real model. The teacher introduces the concept of the cube by showing a cube model, namely dice. When dice are shown, students remember the cube shape. The activity of showing the cube model is intended as a first step to bring back the knowledge that students have (Kurniasih, 2012). Through this step, the activity of presenting the next problem can be carried out by accommodation, which raises new problems by considering the knowledge that students already have.

Furthermore, the relating activities were revealed in the submission of questions, such as: “Do you know to play snake ladders? Monopoly game? In snakes and monopoly games, players alternately move their pieces after throwing the dice. Related to 3 Dimentional shape, what shape is this dice?”. The question is intended to recall memory about the cube concept related to the problem presented. Students respond to questions enthusiastically about the dice and most students answer correctly, namely answering that dice is cube. A small number of other students answer dice shaped box. The shape of the box is considered a concept similar to a rectangular prism. Students often encounter box terms in daily life, such as first aid box, cellphone box, and others. It is an opportunity for the teacher to straighten the term box as a form of rectangular prism which in some cases can be a cube or cuboid.

Then, students are given a stimulus in the form of a problem, namely: "Mention the cube-shaped objects that you know! Cube objects have sides. What shape is the side of the cube? Is each side congruent?“ Students are able to answer with creative examples. Some of them mention that the object they know which is in the form of a cube is rubik. Rubik is the right answer regarding the problems given. There are also students who answer the cube form can be a birthday gift box. The birthday gift box answers get a variety of responses from other students. They revealed that a birthday gift box is not only a cube, but can also a cuboid. Furthermore, to support answers that are considered similar, some students answer that birthday gift boxes can be in the form of cube. It was revealed that there were students who said they had made a birthday gift box in the shape of a cube.

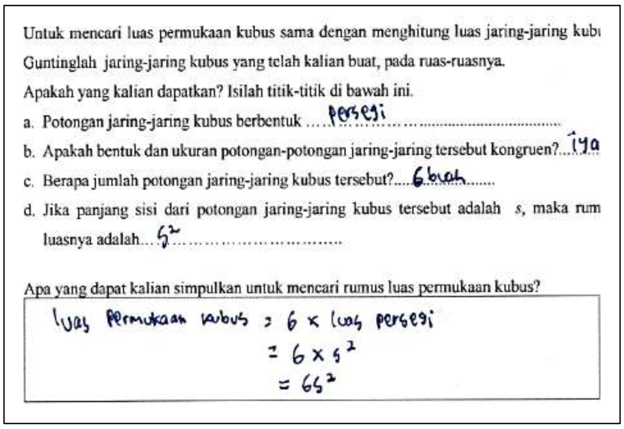
The questions in relating activities are specifically designed to train mathematical representation, reasoning, and disposition ability. The representation ability is raised in the question: "Do you know snake ladder games? Monopoly game? In snake ladder and monopoly games, players alternately move their pieces after throwing the dice. Related to 3 Dimentional shape, what shape is this dice? " The question presents real-world representation given by the teacher to students to bring what they already know with the concepts to be learned.

The teacher gives the question: "Mention the cube-shaped objects that you know!". These questions provide opportunities for students to come up with ideas regarding cube objects in daily life through words. Based on these questions also, students are able to communicate their ideas with different answers. The difference in views about the example of a cube shaped birthday gift box. On the one hand, there are students who say the birthday gift box is in the form of a cube. However, on the other hand there are students who refute the answer on the grounds that birthday gift boxes are not always cube shaped. Students maintain the answer by giving logical reasons why the shape of a birthday gift box is cube. The logical reason given by the student was that he had made a cube birthday gift box. It indicates that there is a reasoning process, namely the efforts of students to maintain their opinions as a truth (Sumarmo, 2010).

The involvement of students in responding to questions from the teacher is a form of mathematical disposition (Polking, 2019). Questions that can be answered by almost all students move from life experience or knowledge that they already have is an effort designed to trigger student involvement in learning. Student involvement is seen in a strong curiosity to know something or to solve a problem. For example, when the teacher provides a stimulus with the question: "Cube have sides. What shape is the side of the cube? Is each side congruent?" Students give a response that implies a strong curiosity by asking the teacher back, "What does congruent mean, mom?". Questions from students are answered with scaffolding in the form of questions that are close to students (Kurniasih, 2012). The teacher shows two sheets of A4 paper with the same shape and size, then the teacher asks the students, "These two A4 papers are examples of mutually congruent objects. Can you estimate what is congruent?" Then the students answer, "Objects are called congruent if the shape and size are the same". Based on this statements, students are able to state that the sides of the cube are congruent.

In experiencing activities, students are guided by the teacher when working on the worksheet so that it will be easier to understand a concept. Experiment is learning in the context of exploration, discovery, and invention (CORD, 2019). Experiencing activities in mathematics learning can also be illustrated by the involvement of students in every design of activities carried out in the classroom, including various instructions through tasks in hand out or worksheet.

Students are given a cube model in experiencing activities (Figure 1). The cube model is designed from six squares combined with the tape. Tape as an adhesive can be released easily, allowing students to obtain various cube nets. Then, the cube nets are drawn by students on the worksheet given. In addition, students are also asked to draw other possible cube nets. Based on the instructions on the worksheet, students are asked to open the tape on the net of the cube they have obtained, so that they get six squares (Figure 1).


Untuk mencari luas permukaan kubus sama dengan menghitung luas jaring-jaring kubu
Guntinglah jaring-jaring kubus yang telah kalian buat, pada ruas-ruasnya.
Apakah yang kalian dapatkan? Isilah titik-titik di bawah ini.
a. Potongan jaring-jaring kubus berbentuk ....persegi.......
b. Apakah bentuk dan ukuran potongan-potongan jaring-jaring tersebut kongruen?...iya
c. Berapa jumlah potongan jaring-jaring kubus tersebut?....6 buah.......
d. Jika panjang sisi dari potongan jaring-jaring kubus tersebut adalah s, maka rum luasnya adalah....s^2.......

Apa yang dapat kalian simpulkan untuk mencari rumus luas permukaan kubus?

luas permukaan kubus = 6 × luas persegi
= $6 \times s^2$
= $6s^2$

Translate:
To find the surface area of a cube is the same as calculating the area of cube nets. Cut out the cube nets that you have made, on the sections.
What did you get? Fill in the blank.

a. Pieces of cube nets shaped **square**
b. Are the shapes and sizes of the webs congruent? **Yes**
c. How many pieces of the cube net? **6 pieces**
d. If the side length of the cube nets is *s*, then the area formula is $\boldsymbol{s^2}$

What can you conclude to find the cube surface area formula?
Cube surface area $= \boldsymbol{6 \times Square\ Area = 6 \times s^2 = 6s^2}$

Figure 1. Result of Student Work on Student Worksheets

Previously, students had known the area formula of a square $= s^2$. Next, to obtain the formula the cube surface area is equal to the total area of the entire side of the cube. Because the cube has six congruent squares, students can conclude that the cube surface area is six times the square area. Next, the surface area of the cube $= 6 \times s^2$. Students learn through reasoning and show ideas for their thinking about the cube surface area with symbolic representation. The results of the reasoning are converted into simple mathematical sentences in the form of formulas. When students reason well, they become more understanding. Deep understanding leads students not to memorize.

Students reason well because the problems given are able to reach them cognitively. Students already know some of the knowledge they need to find the formula for the cube surface area. Problems that are close to the cognitive area guarantee involvement and make student learning more meaningful.

Students actively find the formula for the surface area of the cube. Students also actively ask the teacher about representation by drawing cube nets. Student questions are responded to by scaffolding (Kurniasih, 2012). The teacher gives feedback questions. High curiosity, persistence, and perseverance in solving mathematical problems show mathematical disposition in learning (Polking, 2019).

The applying activity includes the activities of applying mathematical concepts in solving problems on a worksheet. In this activity, the teacher designs the task in the form of questions that are diverse, interesting, challenging, and reasonable in terms of student abilities (CORD, 2019; Harwell, 2003; Crawford, 2001). It can be seen in the following example problem.

Syifa will make a cube box with edge length 20 cm. Then, She will coat the box with wrapping paper. How much wrapping paper is left if the available wrapping paper size is 60 cm x 50 cm?

The example above shows that the assignment given directs students to apply the formula for the cube surface area. First, students calculate the area of wrapping paper, that is 60 cm x 50 $cm = 3000\ cm^2$. Second, students calculate by applying the concept of the cube surface area, $6 \times s^2 = 6 \times (20\ cm)^2 = 2400\ cm^2$. Finally, students calculate the remaining wrapping paper area by calculating the difference in area of wrapping paper with the cube surface area, $3000\ cm^2 - 2400\ cm^2 = 600\ cm^2$. Through this problem, students are trained to reason, which is to conclude problem solving logically and communicate ideas through exposure to mathematical answers (Stacey, 2005; Sumarmo, 2010).

In applying activities, the teacher designs questions to train students' mathematical representation and reasoning ability. This activity certainly simultaneously trains students' mathematical disposition, which are characterized by active involvement of students in solving problems in the worksheet (Sumarmo, 2010).

Cooperating activities are one of a series of activities that students need to gain a deeper understanding (Crawford, 2001). Students build understanding through group discussions and compare each other's representations of problems, represent the steps of problem solving, and compare answers obtained. Students also gain broader knowledge about the discussion themes discussed. It is because through discussion, students can see mathematical problems from many perspectives (Anas & A, 2018; Junedi & Ayu, 2018; Novri, Zulfah, & Astuti, 2018; Wulandari, Praja, & Aminah, 2018; Chen, Yang, & Hsiao, 2016). Discussion friends can also act as controls for solving mathematical problems. For example, some students solve a mathematical problem together. One of them sometimes corrects the selected formula application, corrects troubleshooting steps, or corrects calculation errors that can be seen in Figure 2.

Figure 2. Cooperating and Applying Activities

Cooperating activities provide ample opportunities for students to get information (Crawford, 2001). Students can ask what they do not know to discussion friends without feeling awkward, or students can share information they have in solving problems. On the other hand, in a group sometimes there is only one student who understands the problem and the solving problem steps. When that happens, the student can explain to a discussion friend in his group about the mathematical problems faced. The diversity of acquisition of knowledge that does not always lead to the teacher is a sign of positive learning. Discussion provides space for students to learn more meaningfully because deep understanding is also obtained through communication with other students.

Students who answer correctly give logical arguments while explaining to friends their discussion. Some groups decide to believe the answers obtained without asking the teacher. Some other groups need teacher confirmation about the answers they get. On the other hand, there are also in a group that none of its members can provide the right solution. The teacher does scaffolding to groups who have difficulty with questions (Kurniasih, 2012; van de Pol, Mercer, & Volman, 2019). For example, "How many of one apple are added to one apple?" And followed by a statement “So, suppose s^2 equals one apple”. Students understand the scaffolding of the teacher, so that they finally get the right answers through their own minds. However, there is also another scaffolding, namely when interpreting $(AC)^2 = s^2 + s^2$ as $(AC)^2 = 1s^2 + 1s^2$. The teacher gives knowledge of s^2 as $1s^2$ as a fact. If only a few group members understand the teacher's intentions, then students who don't understand can ask their friends who understand.

Transferring activity is a conscious thinking activity in building concepts and solving problems (CORD, 2019; Harwell, 2003). Transferring activities occur in meaningful and natural learning. The teacher provides space for students to think and deduce their own concepts learned. Transferring activities do not occur in teacher-centered learning. The role of the teacher in transferring activities is as a motivator and facilitator. The teacher as a motivator means that the teacher brings students closer to the learning objectives, while the teacher as a facilitator means that the teacher provides guidance or scaffolding. Students know the concept of the cube surface area by summing the area of all sides of the cube, knowing the number of sides of the cube, and knowing the formula for the square area. On the logical reasoning of the transferring process (the problem above), students calculate the difference in area of wrapping paper with the cube surface area.

Students are involved in learning activities because the problems presented are still in the cognitive area. The problems presented are authentic problems that are presented in a realistic context, namely students are invited to practice applying the concepts through effective problems. Problems presented effectively means providing a context that is close to the lives of students. Observations are carried out as triangulation material to check the implementation of REACT strategy. Observations were carried out during learning in the class that had learning with REACT strategy at each meeting. The assessment results of the observers at each meeting showed that learning activities with REACT strategy were carried out in accordance with the planned learning steps. The assessment results and input by the observer become the improvement material for the teacher in carrying out the learning, so that they involve students actively in accordance with REACT strategy steps.

The meeting that received the attention of observers was the first meeting. At the first meeting, all REACT strategy steps were implemented. However, learning has not been maximized. It is because students are still adjusting to learning. Students are directed to study in groups with REACT strategy. Whereas previously students were accustomed to learning individually, so it was not optimal in solving questions on the worksheet. Valuable input based on discussions with observers to maximize learning, including (1) the teacher must be disciplined in managing the timing of learning steps according to the lesson plan, (2) when students conduct group discussions, the teacher should write down the number of questions to be presented students in front of the class to make time effective, (3) at the end of learning, the teacher must prepare a scaffolding to direct students to make conclusions from the material that has been studied, (4) the teacher must memorize the names of students, so that the teacher can be closer and evoke active involvement of students in learning.

At the second meeting, students and teacher began to get used to learn with REACT strategy. Where the teacher evaluates learning at the first meeting. The teacher's role in managing the class is so important that learning is carried out maximally. The third meeting until the tenth meeting received more attention from observers. It is because of the increased activity of students who are seen while studying in group discussions. In addition, increasing the confidence of students is also seen in classroom learning, for example most students want to come to the front of the class to present answers on the board, ask the teacher without feeling awkward, and express their opinions both in group discussions and class discussions. The solving problems in the worksheet actively involves students. It can be seen from the high curiosity of the students to solve the problem. If students experience difficulties, they will not hesitate to ask friends and teacher. It is in accordance with the teacher's task as a facilitator and motivator.

The implementation of REACT strategy uses instruments and learning tools that have been validated by experts. Hand out that are part of learning tools are developed and used to construct students' knowledge. Hand out for the first to the fifth meeting are given by the teacher to students to learn at home. However, some students do not learn it, even the hand out given by the teacher is not carried out during the learning process. It is seen when students feel confused working on the worksheet and always ask the teacher. Based on this results, the teacher changed the strategy at the sixth to tenth meetings. The teacher shares hand outs and worksheets simultaneously during learning. It has a positive impact because students construct their thinking by learning hand out and worksheet at once (Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher, 2019).

CONCLUSION

REACT strategy is an implementation of a contextual learning approach. REACT strategy can be applied to develop the mathematical representation, reasoning, and disposition ability that involve students actively through the stages. Implementation of the REACT strategy runs smoothly and gets enthusiastic responses from students. It can be seen from the activity of students in every learning activity in the classroom. The activeness of students in the class can be seen from high motivation in learning, activeness of students in discussions in groups, asking the teacher. Students are more excited when learning, especially when the teacher asks students to present the results of their group work in front of the class. The implementation of REACT strategy should be carried out continuously so that the learning objectives can be achieved by integrating various integrated mathematical abilities.

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