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The role of discovery learning in efforts to develop students' critical thinking abilities

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ABSTRACT

This research aims to determine the role of developing and implementing discovery learning models to develop students' critical thinking skills in mathematical story problems. The search was carried out in the even semester of 2022/2023 with research subjects totaling 30 fourth semester elementary school education students. The research was conducted using qualitative analysis methods with data collection through observation, interviews, and documentation. The discovery learning model is implemented through learning stages, namely training students to use various concepts, principles, and skills they have learned to solve the mathematical story problems they face. The research results show that the discovery learning model has an impact on the development of critical thinking skills because the research's observations of critical thinking abilities result in the capacity to recognize, evaluate, and resolve narrative difficulties as well as to reason rationally and ethically to conclude. The discovery learning model provides students with the opportunity to apply learning based on solving mathematical story problems, allowing students to develop critical thinking skills.

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1. INTRODUCTION

The learning model directs us in designing learning to help students in such a way that they can achieve learning objectives [1]. The learning model serves as a guide for teachers in designing the implementation of the learning process. The elements listed in the learning model include the expected situation in the learning model as well as the facilities, materials, and tools needed [2]. It can be said that the learning model procedure is almost the same as the procedure for preparing lesson plans, where there are objectives, materials, teacher and student activities, methods, media, learning resources, and evaluation tools [3]. Education is one of the efforts to improve the quality and potential of each individual. In other words, continuous improvement and development of human resources are very important, especially in the current era of globalization [4]. In his opinion [5] states that teaching and learning conditions in universities in Indonesia in general have not significantly changed academic insight and behavior. This can be seen from the point of view, the way of thinking of students or college graduates who do not show any difference with people who do not receive higher education [6].

Efforts to improve the quality of human resources are a challenge for universities. Ideally, learning in higher education develops the hard skills and soft skills possessed by every student [7]. According to

Poláková *et al.* [8] which includes soft skills, one of which is the ability to think critically and find problem-solving ideas. The ability to think critically cannot develop along with the physical development of each individual [9].

The critical thinking ability of each individual is different [10], depending on the exercises that are often done to develop critical thinking. The reality found in Department of Elementary School Education, Faculty of Teacher Training and Education students at Esa Unggul University shows that in studying mathematics they are still theoretical and do not develop critical thinking skills [11]. Mathematics learning is a compulsory subject in the Department of Elementary School Education. The material in mathematics learning lectures is a basic provision for students to be able to teach mathematics later in elementary school. In elementary mathematics learning lectures, students learn about strategies, approaches, models, and methods in teaching mathematics, how to convey mathematics material appropriately, how to create media and teaching materials that attract students' interest in learning, and can help students understand, know and identify problems that arise. encountered in the teaching and learning process in elementary school, discussing ways/solutions of problem-solving found.

Critical thinking skills are very important to be instilled in students [12], especially Department of Elementary School Education students who are prospective elementary school teachers [13]. If we look carefully, it can be seen that the five goals above show that learning mathematics is learning to organize reasoning [14], shape the personality of students, and be skilled at applying mathematics in solving everyday life problems. This is due to the fact that every human being will always be faced with problems [15]. Viewed from the context of improving the quality of education, the problem-based learning (PBL) model can be used to improve the learning system, especially in mathematics. Learning mathematics in elementary schools should begin with problem recognition or posing real problems, namely learning that relates to students' daily lives, then the teacher guides gradually to master mathematical concepts by involving students' active role in the learning process [16]. Therefore, in learning mathematics in elementary schools, teachers are expected to be able to apply approaches that educate creatively, they can use horizontal and vertical mathematization to solve mathematical problems and problems in the real world [17].

A systematic process for setting up learning activities to meet learning objectives is called a learning model. Put another way, a learning model is essentially a scheme or format that is utilized to create in-person instruction in the classroom and to gather instructional resources [18]. The facts and circumstances of the current classroom, as well as the perspective on life that will arise from the collaboration process between the instructor and students, must be taken into consideration while selecting a learning model [19]. This is an interpretation of the results of observations and measurements obtained from several systems. One learning model that has recently been widely used in advanced schools is the discovery model [20]. A key element of the contemporary constructivist method, which has a lengthy history of innovation in education, is discovery learning [21]. As Bruner contends: "Learning occurs when a student must organize the material on their own rather than being given it in its final form. This type of learning is known as discovery learning." [22]. Learning via discussion, reading independently, and experimentation is known as "discovery learning," which enables kids to learn independently by including them in the mental activity process [23]. The discovery model is a part of teaching strategies that support student inquiry, active learning, process orientation, self-direction, and reflection in the classroom. According to the encyclopedia of educational research. Thus, it can be said that the discovery learning model is a model where in the teaching and learning process the teacher allows his students to discover for themselves [24].

The use of the discovery learning model is considered sufficient in teaching and learning activities on campus. Students can think critically to find problem-solving ideas. Students should become more active in finding problem-solving ideas. This learning model makes students comfortable and relaxed [25]. Thus, the material provided by the lecturer is easily understood and understood by students. The selection of learning models is important to increase or strengthen student learning motivation [26]. A good learning model can motivate students while studying to achieve learning goals [27]. Students also feel that using discovery gives students broad insights that allow students to think critically when solving problems presented by instructors. By connecting problem-solving with real life or everyday life, students can easily find existing problems to solve them correctly [28]. When the COVID-19 pandemic for the last 2 years required an online teaching and learning process, the discovery application also assisted in learning activities [29]. Students can not only solve problems with the help of material provided by lecturers, but students can also learn about finding problem-solving ideas on the internet or other media. Difficult problems make students more active in solving them [30]. Because the more difficult the problems faced, the more curious students are, so students rush to solve them. Online learning during the pandemic made students more relaxed in solving problems [31]. The level of student activity can be seen in the different stages of the PBL model. In the phase of organizing students to study alone or in groups, students discuss and exchange information with their group mates. This is in accordance with what was said by [32], namely student performance indicators can be seen from the perspective of student group discussions. In addition, during the development

and presentation stages of their work, students actively express the results of discussions with their groups, while other students comment on them. At this stage, there is a relationship between students, so they are encouraged to dare to ask and answer questions [33].

Findings from other studies also show that students who are more motivated to learn generally also have higher critical thinking skills, and students who are more motivated to learn are also interested in solving problems and overcoming challenges [34]. This according to this research is based on the results of interviews with student 2, namely, students believe that the teaching and learning process becomes more meaningful because it brings real problems [35], so students are not bored, they have a passion for learning and solving problems. The higher the student learning motivation, the higher the student learning outcomes [36]. One way to increase student learning motivation is to study properly. The role of the instructor is also very important in the discovery learning model [37]. The lecturer's task is to accompany students in teaching and learning activities according to the stages of implementing the discovery learning model. During teaching and learning activities, lecturers can encourage students to easily solve problems according to student answers 2.

Based on the results of various research reports, the application of discovery in mathematics learning can strengthen students' mathematical find problem-solving ideas abilities, because finding problem-solving ideas learning in discovery class activities encourages students to assist in learning activities [38]. In this study, problem-solving ideas abilities were measured by students' ability to find problem-solving ideas in four steps [39]. Understand the problem, plan a solution, implement the solution plan, and verify the accuracy of the results obtained. The research results obtained indicate that the find problem-solving ideas learning model can stimulate student learning and affect the growth of students' mathematical find problem-solving ideas abilities [40]. Discovery also influences content awareness, which gives students better opportunities to be more involved in learning content and increases student active participation, motivation, and interest in learning [41].

PBL allows lecturers to assist students in concentrating on problem-solving in real-world scenarios, which motivates students to actively participate in the learning process, encouraging them to think about problem situations and find solutions [42]. In addition, the application of discovery can also improve students' mathematical communication skills, because the discovery learning process often involves interactions between students and lecturers, which in turn makes students reflect and reflect on pre-existing understandings [43]. The main factor of discovery is emphasized in the learning process, not in the final product or solution. From this situation, students also learn to manage themselves and situations in groups and act in the role of their students. Discovery is a teaching method that focuses on student participation in the learning process [44]. Discovery is a constructivist learning model, a student-centered approach that focuses students on demonstrating reflection and skills in communication and collaboration, requires reflection from abilities in teamwork and communication, and necessitates reflection from multiple perspectives [45]. Therefore, the lecturer must understand his role as a teacher and motivator, guiding and guiding student learning to ensure that they comprehend the subject matter being studied. Additionally, the study demonstrated that students positively impacted their learning results in mathematics [46].

The application of the discovery learning model is used as a solution to the problems faced by students. The results showed that discovery had a positive effect on students [47]. Among them, there are students who better understand the material presented, previously students only knew from the material provided by the lecturer without knowing its application in real life or real life [48]. Another positive effect is that students' insights broaden, previously it was known that some students only relied on material from books provided by lecturers. Students can exchange opinions or information after searching for information outside of books, such as the internet or other media [49]. By using the discovery learning model through the group work method, students participate more actively in finding problem-solving ideas. Shy students become more confident because they need to interact with their classmates [50]. Enhancing student learning processes and results is a major benefit of the PBL approach. Finding problem-solving ideas learning models can use a combination of group collaboration and self-discovery methods to help students find problem-solving concepts [51]. With online learning, groups can be formed by lecturers or students themselves. Once the group is formed, students have options to chat with their friends online such as WhatsApp groups, voice calls, and video calls [52]. The results of the discussion can then be presented to the lecturer via Google Meet. If some do not understand, students can ask the teacher, so students will not be afraid to ask the teacher to master the material taught by the teacher [53].

2. METHOD

A qualitative research technique was employed in this study, and observation, interviews, and documentation were the main methods utilized to collect data. Thirty-fifth-semester Department of

Elementary School Education students served as the research subjects for the even semester 2022/2023. The learning process that takes place while applying discovery learning in an attempt to strengthen critical thinking abilities was the format in which the study's data was collected. Data collection was carried out by researchers by interacting directly with research subjects. By interacting directly, researchers can obtain data in the form of student views/opinions with the application of finding problem-solving ideas seeking to hone critical thinking abilities through education.

The process of gathering information for research purposes through in-person questioning between interviewers and informants, or interviewees, with or without the use of interview guidelines, where interviewers and informants were involved in social life for a considerable amount of time, was the method used to collect data [54]. In this case, the interviewers are researchers, while those interviewed are students who are randomly selected. Interview guidelines were prepared regarding questions that required answers to the opinions of research subjects about the application of the discovery learning model to students' conceptual understanding and critical thinking skills.

This documentation is in the form of recordings and photos. The procedures suggested by the data analysis approach employed in this study [55] are as follows: data collection, data reduction, and verification and confirmation of conclusions. The phases of problem-based education to cultivate analytical abilities consist of 4 stages as shown in Figure 1.

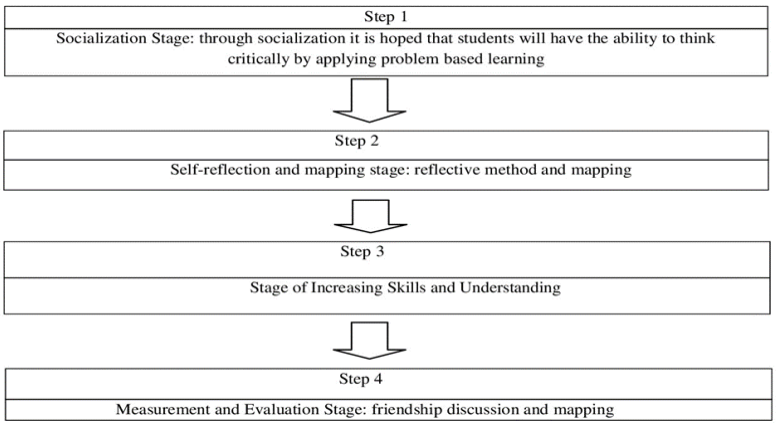

Figure 1. Activity stage and steps

3. RESULTS AND DISCUSSION

In this study the emphasis was on the results of the development of students' critical thinking skills that emerged in each lesson and the initial stages were started to look at students' critical thinking skills.The initial stage was carried out when the researcher conducted outreach to students by providing provision for critical thinking skills and understanding of problem-solving ideas and learning models, exploring, discussing, and answering questions about the elementary mathematics learning subjects that students studied. The results of this socialization are used to determine students' critical thinking skills before the next stage is carried out [56]. The next stage is self-reflection and mapping where at this stage students are invited to carry out activities to identify the strengths and weaknesses of critical thinking skills and understanding discovery learning models of the learning process [57]. This stage uses a reflective method by writing on worksheets and mapping the positions of strengths and weaknesses and solution efforts and improvement commitments that need to be made with the paradigm that has been obtained in stage 1. The next stage is improving critical thinking skills and understanding PBL models with practical activities and simulations until documented with records and records. The final stage is measurement and evaluation carried out through friendship discussions and mapping [58]. An evaluation was also carried out using interviews.Based on the interviews and observations that have been carried out, the writer can describe the development of students' critical thinking skills, along with the interviews that have been carried out, the interview begins with one of the students.

> "*Researcher: what do you understand about elementary mathematics learning? Explain simply?*
> *Students: learning elementary mathematics is learning mathematics to prepare students to be able to use a mathematical mindset in their daily lives and in studying other sciences*." (Interview with students 1, 14 November 2022).

> "*Researcher: what are the stages of learning elementary mathematics? Explain simply?*
> *Students: according to Bruner, the stages of elementary mathematics learning are (1) the enactive stage, at this stage students are directly involved in manipulating objects, (2) the iconic stage, at this stage the activities carried out by students relate to the mental image that has been manipulated, (3) The symbolic stage, at this stage students manipulate symbols or symbols of certain objects.*" (Interview student 1, 14 November 2022).

The results of the interview above show that student 1 can understand the subject of learning mathematics from a theoretical point of view, student 1 is also aware of the need for practice so that when in the field or teaching in class student 1 can innovate so that students can be enthusiastic about learning mathematics.

> "*Researcher: mention the model in elementary mathematics learning? Explain simply?*
> *Students: there are 10 elementary mathematics learning models, namely (1) realistic mathematics learning model, (2) open-ended learning model, (3) example non example learning model, (4) picture n picture learning model, (5) numbered learning model together, (6) the jigsaw learning model, (7) the role-playing learning model, (8) the problem-based learning model, (9) the course horay learning model and the take n give learning model*." (Interview student 2, 14 November 2022).

> "*Researcher: Which of the many learning models do you think is suitable for this course and why?*
> *Students: problem-based learning model, because this learning model has student and teacher interaction regarding strategies, approaches, methods and learning techniques*." (Interview with students 2, 14 November 2022).

The results of the interview above show that student 2 understands enough of each model of learning mathematics to be able to show one of the best models. The concept put forward by Jonassen explains that teachers and students can converse about tactics, approaches, methods, and learning techniques that are employed in the learning process through the usage of learning models [59]. PBL comes from the theory that learning is a process where students actively construct knowledge.

> "*Researcher: what materials are suitable for the problem-based learning model in elementary mathematics learning? Explain simply?*
> *Student: using word problems with material about units of distance, the reason for choosing this material is that calculating distance is an easy thing, this can be a problem that must be solved*." (Interview with student 3, 14 November 2022).

The results of the interview above show that student 3 can understand and explain the right material to solve problems easily and the following are the steps for solving according to student 3, i) The learning objectives are explained by the instructor. Explain the necessary logistics. Encourage students to engage in specific problem-solving activities; ii) Assist students in defining and organizing learning tasks associated with problems (establishing themes, assignments, and timetables); iii) Assist students in gathering pertinent data, attempting to clarify and resolve issues, gathering data, formulating hypotheses, and solving problems; iv) Assist students in organizing suitable assignments, such as reports, and assisting them in sharing tasks with their peers; and v) Instructors support students in considering and assessing their study and the methods they employed. Some examples of inquiries that may be made include:
Example 1: one day, the school held a running competition. Participants must circle the rectangular field 20 times. If the length and width of the field are 12 checkers and 55 m respectively. How many kilometers must each participant run in the race?
Example 2: Budi goes to a bookstore 0.5 km from his house. Coming home from the bookstore, Budi stopped at a minimarket which was 250 m from the bookstore. If Budi returns from the convenience store to his house past the bookstore, how many miles does Budi travel to and from there?

The results of the interviews and answers of each student can then be grouped and explained as follows: when students use critical thinking skills, students will be careful and considerate in making a decision. So that critical thinking skills are also needed in learning because the problems students get are not just problems that are by a given material. So that students not only know about material, but students must be able to apply it in various forms so a high-level thinking ability is needed. This is in line with the opinion of Grabowski *et al.* [60] which states that critical thinking is high-level thinking that not only memorizes but can use and manipulate what is learned in new situations. In addition, Liu and Pásztor [61] also states that critical thinking skills are a high-level thinking process for students to decide so that it leads them to draw the right conclusions. Makridakis *et al.* [62] states the idea of critical thinking is reflective thinking where the

purpose of reflective thinking is to think actively, toughly, and carefully in setting provisions or in forming knowledge and drawing conclusions. This is the same as Kaczkó and Ostendorf [63] stating that critical thinking is a part of reflective thinking and focuses on forming what he believes. Therefore, the ability to think critically can help a learning process to be active. When a problem is designed to use critical thinking skills, students solving it will interact well with the media, other students, or the teacher. In addition, by developing a critical thinking ability, students will get used to analyzing, identifying a problem relating it to others, and then evaluating it before making a decision that is believed to be true. So when students are accustomed to using critical thinking skills in solving a problem, students will be accustomed to solving it critically [64]. So that students when in real life will solve problems well. Because the solution taken is full of consideration and care.

4. CONCLUSION

The study's findings indicate that using the discovery learning approach makes students think more critically in solving a discovery. Discovery is a variation of a good learning model to use so that the material provided by the teacher is easy to understand. With the discovery model, lecturers can encourage students to be more actively involved in teaching and learning activities, making students more confident in expressing their opinions. The difficulty for students in implementing the discovery model is that it is difficult to find information to solve problems presented by lecturers, the basic knowledge possessed by students makes it difficult to solve problems, in online learning the discovery model is not optimal, so the relationship between students and lecturers and relations between students.

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