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IJITE

International Journal of Information Technology and Education (IJITE) 3 (2), (March 2024) 15-23

International Journal of Information Technology and Education (IJITE)

http://ijite.jredu.id

Implementation of the Problem-Based Learning Model in Teaching of Mathematics about Adding Fractions with Different Denominators in Elementary Schools

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ARTICLE INFO
Article history:
Received: January 15, 2024; Received in revised form: February 25, 2024; Accepted: March 02, 2024;
Available online: March 08, 2024;

ABSTRACT

Research has been carried out to find the level of student ability and the level of difficulty of essay questions on fractions, through polytomous data analysis by applying the Rasch model. The research was conducted in the In-Service Professional Teacher Education program, specifically in the Elementary School Teacher Education. The research was conducted at Belang 1 State Elementary School, Southeast Minahasa Regency, North Sulawesi, Indonesia, in grade 6 with a total of 27 students. Experimental research method with one group pretest-posttest design. The experimental treatment is a Problem-Based Learning (PBL) learning model. The test instrument is in the form of an essay with material on adding fractions with different denominators. The instrument was content validated through a video conference forum attended by experts, tutors, and subject teachers. Data was collected through formative pre-tests and post-tests. Scores are processed as polytomy data. Data analysis used the Rasch model with the Ministep 4.3.2 software application. The results of the analysis, as a class group, the pre-test average was 7.0 and the post-test was 77.0. This group's data shows that the use of the Problem-Based Learning (PBL) model in mathematics learning is very effective. Another conclusion is that the Rasch Model can accurately analyze polytomous data and find 1 student who has a high ability exceeding the highest level of test item difficulty in completing the essay test on adding fractions with different denominators. Then the Rasch Model can analyze the level of difficulty of the

5 items of the essay test instrument, it was found that 2 test items had a low level of difficulty. Using the Rasch model, it is consistently detected that adding fractions with different denominators containing the number 7 is categorized as having a high level of difficulty.

Keywords: PBL, Mathematics, Fractions, Elementary School

INTRODUCTION

Research on the use of problem-based learning models in various types of learning and fields of study continues to be carried out today. Anette Markula and Maija Aksela (2022), who are in line with Morisson and Tsybulsky's opinion, expressed the opinion that teachers need to learn through PBL during their pre-service training. Furthermore, for teachers to fully understand the pedagogical approaches required in PBL, both teacher training and research must consider their main characteristics and applications (Markula & Aksela, 2022), (Morrison, et al, 2020), (Tsybulsky & Muchnik-Rozanov, 2019). Especially in mathematics learning, problem-based learning models can connect student reasoning with applications in everyday life. As stated by Aisyah and Usdiana (2021), research findings show that the overall implementation of PBL has a significantly greater positive influence than conventional learning on students' mathematical connection abilities. Because, in implementing the PBL model, students are faced with problems that are closely related to everyday life. This shows that mathematical connection skills are needed, one of which is the aspect of the relationship between mathematics and everyday life (Aisyah & Usdiyana, 2021). One of the materials related to learning mathematics is fractions. According to Monika Bharti (2022), the concept of fractions is often considered one of the most difficult mathematics topics taught in elementary schools, but why do students find fractions so confusing? This is possible because fractions can represent many different things – parts of a whole, divisions, or points on a number line. Or because students' knowledge of whole numbers makes it difficult to understand why one-half is greater than one-third. Maybe it's also because the teacher doesn't understand the subject. It may be a combination of these things. Whatever the reason, the result of all this confusion is often that fractions are taught in a less than meaningful way (Monika Bharti, 2022).

Based on the opinion from the findings of the research results above, the question arises whether the application of the problem-based learning model can provide a solution to learning the topic of fractions. By analyzing the essay test instrument for adding fractions with different denominators, can we find the level of difficulty in solving the math test items on the topic of fractions? For this purpose, research was carried out on the application of the problem-based learning model in mathematics learning on the topic of fractions in elementary schools. The research aimed to apply the Rasch Model in the analysis of polytomy data test instruments for innovative learning in Elementary School Mathematics subjects, and to find the level of students' abilities in mathematics. the topic of adding fractions with different denominators, as well as finding the level of difficulty of essay questions in mathematics on the HOTS (higher order thinking skill) aspect.

CONCEPTUAL FRAMEWORK

The 21st-century era demands abilities, competencies, and expertise that can compete in global forums. This situation has forced the learning process in schools to adapt to the need to fulfill these demands, including through the application of the problem-based learning model. Rebbeca Otsby (2022) in her thesis research suggests that another result that might be achieved from a curriculum that focuses on problem-based learning is improving collaboration, communication, and leadership skills that can be applied to future careers (Ostby, 2022). In other words, the application of the problem-based learning model can improve a person's skills according to the demands of the 4Cs (critical thinking, creativity, collaboration, communication) which are the characteristics of innovative learning in the 21st century. This is in line with the views of Elaine and Goh (2016), who stated that problem-based learning is an effective teaching and learning approach especially if evaluation is carried out for long-term retention and application of knowledge (Ekaine & Goh, 2016). Therefore, it is quite reasonable that professional teacher education in Indonesia establishes the problem-based learning model as the main reference for implementing learning processes by teachers at all school levels.

In terms of the relationship between application in mathematics learning, Suparman et al (2020) analyzed various inconsistent research findings regarding the influence of problem-based learning in improving mathematical problem-solving abilities. Based on a meta-analysis study, it was found that the application of problem-based learning as a whole had a significantly greater positive influence than conventional learning on students' mathematical problem-solving abilities in Indonesia based on the random effect model (Suparman, et al, 2020). Researchers suggest that the mathematical concept of fractions is a challenging topic for teachers and students. As stated in research by Komang Diputra et al (2022), it was found that in aspects of mathematics teachers had limited knowledge and even had a wrong understanding of beliefs, especially regarding the meaning of fractions as part of a whole. In the didactic aspect, there is a tendency for teachers to teach topics and parts of the thinking process that are required in textbooks. In other words, learning is carried out as an imitation of what is in the textbook (Komang, et al, 2022). Therefore, in learning mathematics on fractions, teachers must be inspiring and creative in managing the class, planning learning, and implementing the learning process. Adeeb Jarrah and Almassri (2022) presented the results of research on the problem of learning mathematics on the topic of fractions based on an investigation into the positive impact of using digital game-based learning (ABACUS) on student performance when studying the topic of fractions (Komang, et al, 2022).

METHODS

The research was carried out using experimental methods. one shot pretest-posttest design. The treatment applied in the classroom learning process is problem-based learning. The problem-based learning model applied consists of 5 stages, namely (1) orientation to the problem, (2) organizing students, (3) guiding the study through group discussions, (4) presenting the results of the discussion

and presenting the results of the work, (5) analyzing and evaluate students' abilities and work results. The number of respondents was 27 Class 6 students at Belang 1 State Elementary School, Southeast Minahasa Regency. The mathematics teachers who carry out the learning are Elementary School Teacher Education students at the Manado State University Professional Teacher Education program. Collecting research data through an essay test instrument on adding fractions with different denominators. The test consists of 5 items and is validated by content through focus group discussions via video conferences which are attended by lecturers as experts, tutor teachers, and teachers as students of the in-service teacher professional education program. The learning process in the research class was recorded and uploaded on YouTube with the link: youtube.com/watch?v=diACaiYZz-A. Pre-test and post-test data were taken through formative tests in mathematics learning classes. Scores are processed as polytomy data. Data processing and analysis uses the Rasch model with the Ministep 4.3.2 software application.

The results of data processing and analysis are shown in Figure 1.

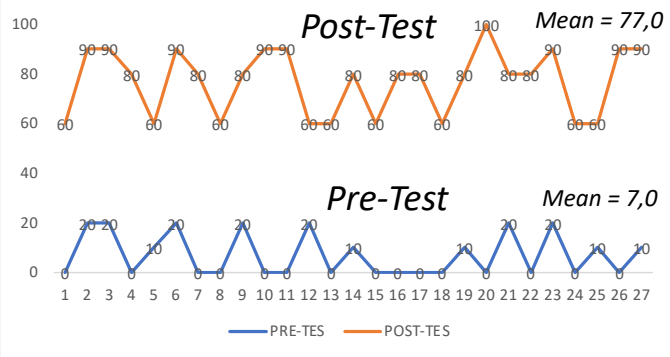

Figure 1. Pre-test and post-test scores for essay questions on adding fractions with different denominators

RESULTS AND DISCUSSION

The results of data analysis are displayed in the Wright Rasch model map, which is a map of individual items, shown in the following figure 2.

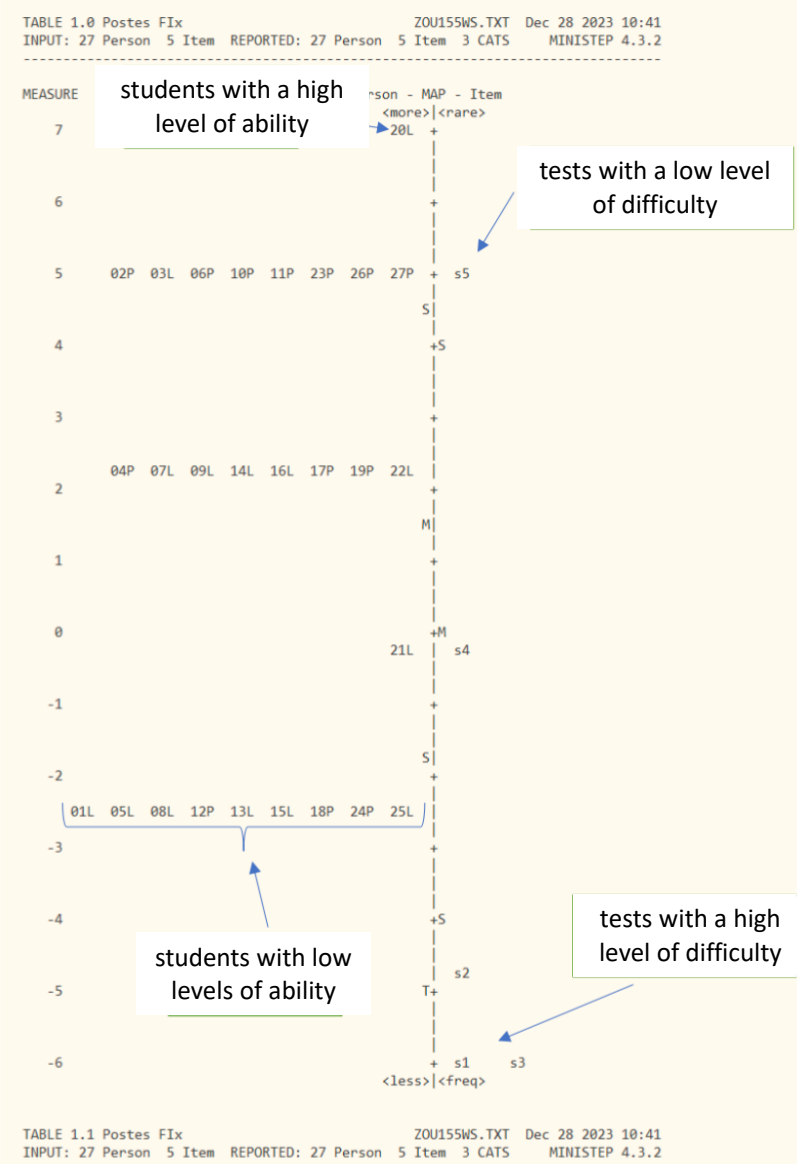

Figure 2. Wright Model Rasch Map Analysis

Based on the Wright Rasch Model Map Analysis shown in Figure 2, the results of the analysis of individual student abilities and the level of difficulty of the test items are shown. Of the 27 students as respondents, it was found that 9 students had high abilities in adding fractions with different denominators. Then, of the 5 essay test items on adding fractions with different denominators, 2 test items were found to have a low level of difficulty, as shown in Figure 3. Furthermore, 3 essay test items were found in order, number 2 had a medium level of difficulty as seen from the logit scale value, and questions number 4 and number 5 had a high level of difficulty.

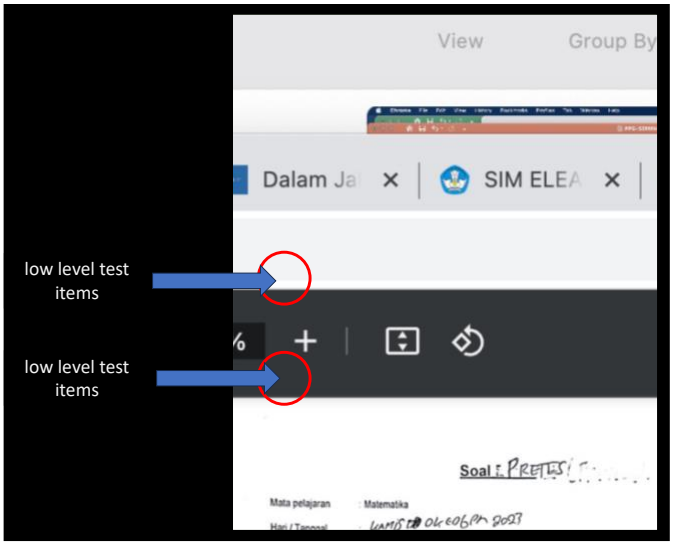

Figure 3. Essay test instrument for adding fractions with different denominators

In Figure 3, it is consistently found that the test instrument for adding fractions with different denominators containing the number 7 is categorized as a test item that has a high level of difficulty. Compare it with the DIF curve shown in Figure 4.

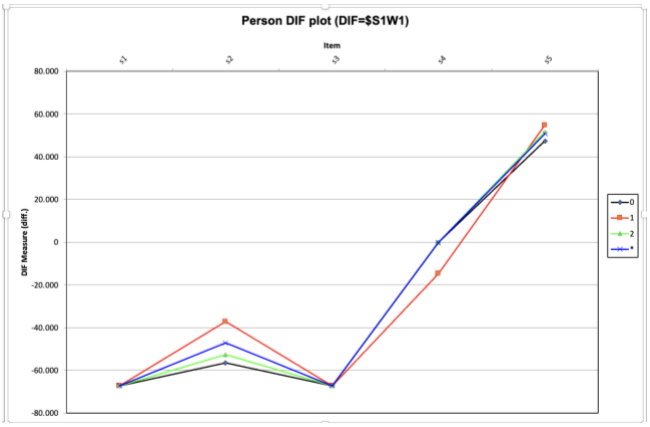

Figure 4. Differential Item Functioning (DIF) curve

The DIF curve shown in Figure 4 is a curve that informs the level of differences in respondents' abilities based on gender (1 male, 2 female), which is also related to the level of difficulty of the questions.

Viewed as a class group, the post-test average score increased very convincingly compared to the pre-test average score as shown in Figure 1. This shows that the application of problem-based learning is very effective as a learning model in mathematics learning, as stated by Miray that problem-based learning is effective in helping students gain a positive attitude towards subjects (Miray Dağyar Hacettepe, 2016).

Examining the results of the Wright Model Rasch map analysis in Figure 2, regarding the abilities of individual respondents, there were 17 students, or 63% of respondents who were detected to have above average abilities, meaning that the application of the problem-based learning model proved effective in making students learn more actively. This follows the opinion of Firdaus et al that the Problem-Based Learning model is very effective in increasing students' mathematical literacy (Firdaus, et al, 2017). Based on the Rasch Model Map, it was also found that 9 students were able to answer questions that had the highest level of difficulty, namely item number 5 adding different fractions, as shown in Figure 3. Students who had a low level of ability were only able to answer 2 questions that had a low level of difficulty. and 1 question that is categorized as medium level of difficulty. That is why studying mathematics on adding fractions, especially fractions with different denominators, is very important to prioritize understanding the concept of whole quantities. This was stated Robin Schumacher (2017) that teaching must emphasize understanding of quantity to increase the understanding of fractions adequately for all students in upper elementary grades (Schumacher, et al, 2017). The distribution of individual respondents' abilities was within one standard deviation-SD(S), except for 1 respondent who had abilities above the highest item difficulty level. This means that the distribution of individual respondents' abilities is in the area around the average value.

CONCLUSION

Classically, the use of the Problem Based Learning model can effectively condition students to be active in the learning process which has the impact of increasing students' cognitive abilities. It turns out that polytomy data from essay questions can be processed and analyzed using the Rasch Model which is displayed in the Wright Map to show the person-item map. Based on polytomous data, by using the Rasch Model, the abilities of low-ability and high-ability students can be identified and can analyze the level of difficulty of test instrument items which can be categorized as high-level difficulty and low-level difficulty. Then, using Rasch Model analysis, it was consistently found that the number 7 is a number that creates a high level of difficulty in the operation of adding fractions with different denominators. Regarding individual abilities in solving test items for adding fractions with different denominators with high and very high levels of difficulty, there was no gender dominance, meaning that the individual abilities of both male and female students had the same opportunity to have the ability to complete the test items.

ACKNOWLEDGMENT

Thank you to the Director General of Teachers and Education Personnel, Director of Teacher Professional Education, Ministry of Education, Culture, Research and Technology, who has allocated Higher Education Development Funds for universities providing Teacher Professional Education. Thank you to the Rector of Manado State University who has fully supported the implementation of the Teacher Professional Education program. Thank you to the Head of the Research and Community

Service Institute, Manado State University, who has approved and supported the collaboration in implementing the Teacher Professional Education Scheme for research and community service activities for PPG lecturers. Thank you to the PPG teachers who have become partners in guiding PPG students. Special thanks to Meidy Wantu, a Teacher at Belang 1 State Elementary School, Southeast Minahasa Regency, North Sulawesi, who is a PPG student and a teacher in Field Experience Practice from which the data for this research can be collected. Thank you to all PPG students in the Elementary School Teacher Education Study Field who were an important part of the video conference on the learning process at PPG In-Service.

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