UJMER 11 (2) (2022): 159 - 164

Unnes Journal of Mathematics Education Research

http://journal.unnes.ac.id/sju/index.php/ujmer

Problem Solving Skills in Challenge-based Learning with Tutor Feedback Based on Cognitive Style

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Article Info

Article History:
Received :
10 Septemebr 2022
Accepted:
08 October 2022
Published:
30 December 2022

Keywords:
Challenge-based Learning, Cognitive Style, Tutor Feedback

Abstract

This study aims to identify the problem-solving skills in challenge-based learning by utilizing tutor feedback from students in terms of cognitive style. The research subjects were grade 10 students of Pekalongan Islamic High School in the 2021/2022 academic year. A qualitative method was employed in this study, while data collection techniques utilized a mathematical resilience questionnaire and interviews to determine students' mathematical reasoning skills. The results showed that 1) field-independent subjects' problem-solving skills were measurably stronger than those of field-dependent subjects. FI subjects can determine the information asked in the problems and explain them; 2) FD subjects encounter obstacles in applying concept knowledge, implementing various effective strategies to solve problems, and reflecting on the problem-solving process.

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p-ISSN 2252-6455
e-ISSN 2502-4507

INTRODUCTION

One of the mathematical competencies that students must pursue is problem-solving skills (NCTM, 2000). In solving problems, a student requires adequate understanding and skills. They must also have varied strategies to select and employ when encountering different problems. The ability to solve problems in mathematics is the core of mathematics learning (Daneshamooz et al., 2012). Efforts to enhance students' problem-solving skills involve designing innovative learning models that motivate students to learn mathematics. Mathematics learning generally still adopts the classical method. The delivery of learning materials and teaching and learning activities should focus more on memorizing formulas for solving mathematics problems and transferring knowledge from teachers to students. Therefore, an innovative learning model is essential to improve students' problem-solving skills (Marlissa & Widjajanti, 2015). However, establishing innovative learning models shall follow the learning environment, students' characters, and learning materials (Aryawan et al., 2014).

One of the methods of mathematics learning to develop is Challenge-based Learning. It is a specific type of problem-based learning where the problems are natural and realistic (Johnson & Adams, 2011). An effective and efficient framework for learning and solving real-world challenges exists in Challenge-based Learning (Vilalta-Perdomo et al., 2020). The framework is direct and collaborative, requiring all participants - students and teachers - to actively identify the Big Idea, ask the Good Question, encounter and overcome obstacles, attain in-depth knowledge, exchange ideas, and foster 21st-century skills. This learning aims to facilitate learners to discover methods of presenting or solving problems (Yoosomboon & Wannapiroon, 2015). To optimize Challenge-based Learning, new methods, such as tutor feedback, are necessary for teaching and learning activities to minimize and direct effective learning. The tutor is a teacher who provides feedback to students in the learning process. They should be responsive and focus on the students.

Formative assessment aims to increase the intensity of feedback and follow-up action on the study results to overcome deficiencies in learning activities. However, the feedback given by mathematics teachers during formative tests is less intensive, which can increase the students' misconceptions regarding mathematical procedures, concepts, and principles. Consequently, this situation can create student learning difficulties (Feedback & Wasiran, 2017). Furthermore, the implementation of tutor feedback can minimize classroom learning problems.

Every student in the classroom's teaching and learning activities has their differences. To determine their problem-solving skills, teachers must recognize their differences. This method affects the learning quality. Students need more knowledge to improve learning outcomes. Each student responds differently to processing, absorbing, and organizing learning materials from the teacher. Individual differences in processing and preparing information and experience are known as cognitive styles (Kane et al., 2016). The cognitive style of field-independent and field-dependent was observed in depth, where they are widely knowledgeable on educational issues. Therefore, it is vital to study the cognitive style of field-dependent and field-independent types. Subjects with field-dependent and field-independent styles have fundamental differences in solving mathematical problems, particularly in processing symbol messages and storing and using information responding to a particular task (M, 2016).

This study's objective was to investigate students' problem-solving skills in terms of cognitive style through Challenge-based Learning with Tutor Feedback in mathematics learning.

METHOD

A qualitative method was employed in this study. The subjects of the study were 10th-grade students of Pekalongan Islamic High School in the 2021/2022 academic year from class X MIPA1 and class X MIPA 2, totaling 30 students. Meanwhile, the object of this study was students' problem-solving skills with field-independent and field-dependent cognitive styles in the experimental class. The subjects of the study were all students in the class. Then, six experimental class students were selected based on their cognitive style test (GEFT) results.

A questionnaire, interviews, and documentation were employed as the data collection techniques in this study. Additionally, the data collection techniques also utilized.

1. questionnaires of mathematical resilience,

2. interviews to identify students' mathematical reasoning skills,
3. validation results of the learning instruments, and
4. observation sheets of teacher and student activities.

The data collection instruments were prepared and tested for eligibility by expert validators. On the other hand, the qualitative data analysis covers the credibility, transferability, dependability, and confirmability tests.

RESULTS AND DISCUSSIONS

Challenge-based Learning Quality Analysis with Tutor Feedback

a. Planning Stage

Challenge-based Learning in mathematics with Tutor Feedback on problem-solving skills is of good quality if the validation results of the instruments, which consist of syllabus and lesson plans, are favorable at the lesson planning stage. Therefore, the Challenge-based Learning evaluation with Tutor Feedback on problem-solving skills is also functional.

earning instruments were designed before conducting research as a teacher's duty. The learning instruments are syllabus, lesson plan (RPP), student worksheet (LKS), and problem-solving test.

Furthermore, learning instruments suitable to the curriculum at Pekalongan Islamic High School were organized, implemented, and aligned with the Challenge-based Learning problem-solving skills with tutor feedback regarding cognitive style. Afterward, the developed learning instruments were evaluated by validators. It aims to measure and assess the feasibility of the learning instruments to be employed. Two competent and expert people, namely lecturers, will validate the learning device. The table of validation results is presented as follows.

Table 1. Learning Instrument Validation Results

Instrument	Validator	Category
Syllabus	4.11	Good
Lesson Plan	4.11	Good
Problem-solving Skills Test	4.17	Good
Math Challenge Sheet	4.00	Good

Berdasarkan pada tabel diatas validasi perangkat pembelajaran hasil yang ditunjukan adalah bahwa perangkat pembelajaran bisa digunakan dengan revisi karena pada kategori "Baik". Revisi perangkat pembelajaran yang digunakan sesuai rekomendasi dari validator yang selanjutnya bisa diterapkan pada proses pembelajaran.

b. Implementation Stage

The implementation stage assesses the quality of learning by observing the teacher's teaching and learning instrument implementation with an observation sheet. The assessment also focuses on the teacher's ability to manage and implement Challenge-based Learning with Tutor Feedback on problem-solving skills.

The implementation of the learning method on problem-solving skills based on several learning sessions in the classroom was in a suitable category with revisions. The findings show that teachers successfully organized and implemented the stages in Challenge-based Learning with Tutor Feedback on problem-solving skills. The score at each learning session has increased. Moreover, the teacher also evaluated the learning in each teaching and learning activity.

c. Assessment Stage

In this assessment stage, the learning quality is measured quantitatively to determine students' mastery of problem-solving skills, particularly in experimental and control classes. The learning quality in this study is an assessment of the preparation, implementation, and evaluation stages of the developed learning. Furthermore, the assessment is conducted at the preparation stage.

On the other hand, the learning instruments employed are developed at the planning stage. The instruments are syllabus, lesson plans (RPP), student worksheets (LKS), problem-solving skills tests, and cognitive style tests (GEFT) evaluated by validators.

The validation aims to measure and assess the feasibility of employing learning instruments. The syllabus validation results belong to the excellent category and are feasible to utilize according to the validators. It has complied with indicators such as identity, core competencies, essential competencies, teaching material sources, learning models, media, and evaluation. Moreover, the developed lesson plans and learning instruments related to this study are also qualified to be implemented according to the expert

validators. The learning instruments were designed with clear concepts and presented with explicit instructions with appropriate materials aligned with the essential competencies. The lesson plans also fit the identity indicators, KI, KD, learning material indicators, models, strategies, media, learning resources, and learning assessments.

The problem-solving skills test is eligible to be utilized even though it requires improvements. On the other hand, the problem-solving skills test was designed with indicators of pattern problem-solving as per Challenge-based learning with tutor feedback. Furthermore, another test in this study is the GEFT to classify the students' cognitive style, where the student worksheet is viable, although it requires improvement in language use. The validation assessment results showed that the average value of each learning instrument was in the excellent category making the instrument appropriate to employ.

Assessment of learning quality occurs at the assessment stage. This stage analyzes the data of students' midterm test results. The test results showed that the average student score was 84.8. However, the minimum score limit of problem-solving skills in Challenge-based Learning with tutor feedback is higher than the average student test results in classical learning. The finding is in line with Van der Kleij et al. (2015) who suggested that feedback is an efficient means of improving student learning. It can facilitate students to identify problems, correct errors, and evolve efficient and effective solution strategies when administered appropriately. Recent studies have shown that feedback can also serve as an effective medium to engage students in learning activities. Hattie and Timperley (in Song et al., 2017) asserted that feedback could assist in bridging the gap between expected outcomes and students' understanding when targeted at the right level.

The students' mathematical problem-solving skills who received problem-based learning were better than those who did not (Jatisunda & Nahdi, 2020). There are differences in mathematical problem-solving skills in each category of initial mathematical proficiency in both classes studied. The high category of initial mathematical proficiency positively affects mathematical problem-solving skills more than moderate and low initial mathematical proficiency. Therefore, the initial math proficiency category is better than the others. Furthermore, there was an integration between the learning methods and the initial mathematical proficiency in mathematics problem-solving skills.

Problem-solving Skills Viewed from Cognitive Style

The qualitative research aims to identify the students' problem-solving skills in mathematics based on cognitive style. FD subjects can specify information and explain questions 1 and 3 well in the understanding, identifying, and modeling stages of mathematics problems. However, there was no distinction between their explanation and the problem description. Meanwhile, FD subjects need more improvement in implementation, preparation, completion, and rechecking stages of mathematics problem-solving processes and results.

Field-independent subjects' problem-solving skills are better than field-dependent subjects' students. Field-independent subjects can master the four indicators of problem-solving skills based on NCTM (2000) well. Meanwhile, field-dependent subjects have yet to master the four indicators of problem-solving skills well (Arifin et al., 2019).

On the other hand, Wakit believed that students' problem-solving results showed that FD subjects could only meet some problem-solving indicators and required further assistance in solving problems. However, by using Polya's method, FD subjects can overcome obstacles in using concept knowledge and employ appropriate strategies to solve and reflect on problem-solving.

FI subjects can specify information and explain questions 1 and 3 well in the understanding, identifying, and modeling stages of mathematics problems. However, there was no distinction between their explanation and the problem description. Meanwhile, FI subjects need more improvement in the implementation, preparation, completion, and rechecking stages of mathematics problem-solving processes and results.

Field-independent subjects' problem-solving skills are better than field-dependent subjects' students. Field-independent subjects can master the four indicators of problem-solving skills based on NCTM (2000) well. Meanwhile, field-dependent subjects have yet to master the four indicators of problem-solving skills well (Ulya & Rahayu, 2020).

This qualitative analysis indicated that FI subjects had better problem-solving skills than FD

subjects. Students with varied cognitive styles can solve varied problems as well. Therefore, teachers can analyze students' cognitive styles with GEFT to enable them to provide learning to students to fit their needs (Prabawa, 2017).

Based on the investigation results, students are intensely interested in ethnomathematics objects. However, not all ethnomathematics objects are directly observable. Hence, ethnomathematics nuanced mathematics teaching materials featuring objects directly observable by students should be provided to enhance their understanding. The study's results showed that FI subjects were weaker than FI in solving problems despite all problem-solving indicators being fulfilled. In conclusion, students' ability in problem-solving can be optimized if established through effective learning strategies and designs that consider the characteristics of each student's cognitive style.

CONCLUSION

The study's results revealed that FI subjects could specify information and explain questions 1 and 3 well in the understanding, identifying, and modeling stages of mathematics problems. Meanwhile, they need more improvement in the implementation, preparation, completion, and rechecking stages of mathematics problem-solving processes and results. On the other hand, FD subjects could only meet some problem-solving indicators and required further assistance in solving problems. However, they can overcome challenges using concept knowledge and employ appropriate strategies to solve and reflect on problem-solving.

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