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Getting Offer Learning Design to Improve Mathematical Communication Skills in Higher Education

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Abstract

Innovative and problem-based getting offer learning design is applied with jigsaw cooperative learning and flipped classroom strategy to encourage students to communicate mathematical ideas and solutions clearly and systematically and provide interactive learning experiences for students. This study aims to develop a getting-offer learning design that meets the criteria of valid, practical, and effective in improving students' mathematical communication skills. Mathematical communication is one of the important competencies that supports the understanding of mathematical concepts and the ability to solve mathematical problems effectively. The getting-offer learning design process is described systematically by referring to the Ploom (2013) development procedure, namely, (1) the preliminary research stage, this stage will carry out a needs analysis and content analysis, (2) the prototyping phase, this stage will design the getting offer learning design and compile learning tools, (3) assessment phase, carried out by implementing learning design and learning tools. This study involved 30 students of the 2024 intake in the Mathematics Education Department of UIN Alauddin Makassar. The study results indicate that the learning design has met the valid criteria with an average validation result of 3.82 in the very valid category, the practicality criteria of the design with a very positive category, and the effectiveness criteria with a high category. This study is expected to contribute to developing effective learning designs to improve mathematical communication skills in higher education, as well as provide new insights into the implementation of problem-based learning designs in the context of higher education.

Keywords

Getting Offer, Mathematical Communication, Mathematics Learning

Introduction

Communication skills need to be developed in the teaching and learning process because this ability is one of the basic generic skills (CDC) of Hong Kong and is one of the science process skills that students must have. Dogan & Kunt (2016) and Kefi & Uslu (2015) stated that to achieve optimal success in learning activities, a process of building effective communication relationships between teachers and students must be established. Through communication, an idea becomes an object of reflection, improvement, discussion and change, and this is a process that helps build meaning and establish ideas, and makes these ideas generally applicable (Hafriani, 2021; Kamid et al., 2020). The importance of communication in mathematics is also reflected in the ability of 21st-century skills, including critical thinking, communication, collaboration, and creativity.

Objective communication skills reflect the extent to which students have mastered the concepts of the material or problems being solved. A review of why some studies focus on improving communication skills is that communication skills reflect students' understanding, which is followed by a significant increase in other skills. On the other hand, prospective teacher students are required to be able to master and teach mathematics effectively (Parinata & Puspangtyas, 2022; Hafriani, 2021). This is one of the 21st-century skills that several studies are focused on.

The description of students' mathematical communication skills in various universities in Indonesia shows the importance of learning models in minimizing the low level of students' communication skills. Based on several relevant studies, students' mathematical communication skills in various universities in Indonesia are still relatively low. Students still struggle to communicate solutions to various mathematical problems (Turmuzi et al., 2021; Muchlis et al., 2018; Asyura & Dewi, 2020; Nadlifah & Putri, 2023). The low level of students' mathematical communication skills in various universities in Indonesia is a big task for teachers to find alternative learning that can be applied, such as interactive learning designs, models, or strategies, the use of technology, and improving other skills that support the development of student's communication skills.

The communication skills of students in Indonesia in various literatures are proven to be still relatively low, as seen from several obstacles that still often occur. One of them is in explaining, understanding, and applying calculus. The main difficulty lies in understanding the concepts and principles of mathematics (Baye et al., 2021; Erdriani & Devita, 2019; Jannah et al., 2019; Jufri, 2022; Laja, 2022). Based on Newman's Error indicator, the highest errors in mathematics education students in order are encoding errors, process skills errors, transformation errors, and comprehension errors (Ningsi et al., 2022). This condition also occurs in Mathematics Education students at UIN Alauddin Makassar through observations of the answers to the Mid-Semester Exam for the calculus course. The questions require students to solve the function derivative problem correctly, but most students have not been able to solve the questions correctly. It indicates that students' mathematical communication skills are still lacking. It was reinforced during the discussion process, where students were asked to explain mathematical ideas verbally related to the limited material, but only 3 out of 25 students were able to explain their ideas. Based on this, lecturers must try to improve students' understanding of concepts by implementing interactive learning models, designs, and strategies.

An alternative that can be done to minimize this sustainable problem is to create an appropriate learning design. Several previous studies that have created learning designs include the implementation of learning methods that combine Cooperative Based Learning (CBL) with Problem-Based Learning (PBL), which aims to improve learning outcomes and student

involvement (Rahma et al., 2024). Cooperative learning design of the Team Games Tournament (TGT) type with the Physics Ludo game aims to create an interactive and enjoyable learning experience (Ekawan et al., 2015). Developing a Jigsaw-type Cooperative learning design with local Ngada culture in thematic learning aims to improve critical thinking skills (Tando et al., 2021). Learning designs are developed by combining models, learning theories, learning strategies, use of science and technology, or other relevant components.

One approach that can be optimized is the getting offer learning design, which focuses on the active involvement of students in discussions and collaborative problem-solving. This design is expected to help students more easily organize their thoughts and convey mathematical ideas effectively. The jigsaw cooperative model and flipped classroom strategy integrated into the getting offer design enable students to think critically and creatively and hone their mathematical communication skills in real situations (Ismail, 2020). Getting offer is taken from several learning activity designs, including student activities that are offered several discussion material lists for several meetings in a course, student activities that are offered roles, and student activities that are offered the use of several mathematical software that can be used as simulation references in their presentations. The getting offer learning design is applied in a flipped classroom, with its implementation referring to group discussions (cooperative learning) and supported by the use of technology such as the Learning Management System (LMS).

The learning design that integrates the choice of discussion materials, role offerings in groups, and the use of mathematical software aims to improve students' mathematical communication skills through the flipped classroom approach and cooperative learning by giving students the freedom to choose relevant materials, they can be more involved and motivated in understanding mathematical concepts, while interactions in group discussions encourage effective communication practices, and visualization of ideas through software improves understanding and delivery of solutions analytically, so that it is expected to overcome the problem of low mathematical communication skills that are often faced (Mohebbi et al., 2022). The learning design that is created is expected to be a solution to the problem of students' low mathematical communication skills. Because LMS supports the getting offer learning design, it is very possible for students to interact outside the classroom (Karjo et al., 2021). This study aims to design getting offer learning that meets the criteria of valid, practical, and effective in improving students' mathematical communication skills.

Methods

This study uses the type of Educational Design Research (EDR) research by referring to the Plomp development model, which consists of 3 stages, namely: 1) preliminary research, 2) prototyping phase, and 3) assessment phase (Akker et al., 2013). The location of this research was conducted at the Alauddin State Islamic University, Makassar. The population studied was 30 students of the 2024 intake who were registered in the Mathematics Education Department, Faculty of Tarbiyah and Teacher Training. The number of samples is representative enough to represent the population of students majoring in mathematics education so that the quality of the information obtained can be explored and analyzed correctly.

Furthermore, a getting-offer learning design will be designed, supported by learning tools: implementation of learning design, lecturer response questionnaire, student activities, student response questionnaire, and student mathematical communication ability test. Two experts in

their fields will validate the validation test of the design and learning tools. The practicality test will be seen from implementing the learning design through the learning design implementation sheet and the lecturer response questionnaire. The effectiveness test will be assessed based on the analysis of student activity sheets, student response questionnaires, and students' mathematical communication ability tests.

The indicators of mathematical communication ability used in this study are: 1) the ability to identify information; 2) the ability to express mathematical ideas; 3) the ability to use terms, notations, and structures; and 4) the ability to draw conclusions. The validity and practicality tests of the learning design were carried out in accordance with the steps of the data analysis procedure according to Hobri (2010). The effectiveness test of the learning design was analyzed quantitatively.

Results

1. Preliminary research

In this initial stage, several preliminary studies were conducted, such as needs analysis and content analysis of the getting offer learning design process. In the preliminary research stage, the results of the initial investigation of the design are described.

(1) Analyze and elaborate on relevant sources: learning theories that support design development, curriculum analysis, and learning process analysis.

a) Learning theories that support design development include cybernetic theory, which emphasizes everything related to the internet, artificial intelligence, and computer networks. Social cognitive theory in Bandura's theory explains that the environment, behavior, and personal factors play a significant role in learning. Brunner's theory is a learning theory whose level of success can allow students to discover concepts independently. APOS theory is a learning theory that emphasizes the importance of interaction between people in understanding mathematical ideas. Social constructivist theory holds that knowledge is built by humans little by little, and the results are expanded through limited contexts and occur over a long period.

b) The learning design of getting an offer with the SAMR framework is a learning approach that aims to connect mathematical material with the real world. So that students will understand the concept well and can apply it in everyday life.

c) Jigsaw cooperative learning and flipped classroom strategy where each group member will choose their respective roles in a group consisting of technology experts and material experts as an application of the jigsaw cooperative learning model. The flipped classroom strategy combines online and offline learning, so that students will prepare discussion materials carefully before making a presentation.

(2) Jigsaw cooperative learning and flipped classroom strategy: Each group member will choose their respective roles in a group consisting of technology and material experts, applying the jigsaw cooperative learning model. The flipped classroom strategy combines

online and offline learning, so students will prepare discussion materials carefully before making a presentation.

(3) Conducting observations and analysis of the learning process, including student conditions, lecturer conditions, and environmental demands on mathematics learning. Analysis of the learning process: The learning process implemented by lecturers uses discussion and question-and-answer methods. However, it seems monotonous, so students feel bored with the ongoing learning process. Creating an interactive and innovative learning design is the right way to anticipate this ongoing problem. The learning design offered in this study is the getting offer learning design with jigsaw cooperative learning and flipped classroom strategy.

2. Prototyping phase

The prototyping stage produces a draft of the getting offer learning design supported by two things, including (1) an initial draft of the getting-offer learning design guidebook with the SAMR framework for jigsaw cooperative learning and the flipped classroom strategy and (2) an initial draft of the instruments used to obtain the required data in the form of a learning design implementation sheet, student response questionnaire, student activities, student response questionnaire, and communication skills test.

3. Assessment phase

The assessment stage is very important in the Plomp development model stage. The design and learning devices will be tested and evaluated to determine how practical and effective the getting offer learning design improves students' mathematical communication skills (Akker et al., 2013). The getting offer learning design and the learning devices developed will be tested on a small scale. The trial was conducted three times and involved two universities, namely the Universitas Muhammadiyah Makassar (Unismuh) dan Yayasan Pendidikan Ujung Pandang (YPUP), which focuses on the mathematics education department.

The learning design of getting-offer and learning devices have been validated by two experts with an average validation result of 3.82, which is in the very valid category, meaning that the learning design of getting-offer and learning devices are ready to be tested on a small scale. The trial has been carried out three times. The results of the trial stage one of the learning design and learning devices have met the criteria for practicality but are less effective because there are still several steps in learning getting-offer that students have not implemented properly. The second trial that was carried out met the criteria for practicality with a positive category and the criteria for effectiveness with an average N-Gain score of 65.21% in the fairly effective category. The third trial also met the criteria for practicality with a positive category and the criteria for effectiveness with an average N-Gain score of 69.22% in the fairly effective category.

Furthermore, a large-scale trial was conducted, then implemented in the Mathematics Education Department of UIN Alauddin Makassar. The results of the practicality analysis

provide the results of the application of the learning design getting-offer that has met the criteria for practicality with a very positive category. Furthermore, the results of the effectiveness analysis have met the effectiveness criteria with an average N-Gain value of 85.99% in the effective category.

Discussions

This study began by identifying the problem to be solved, namely, related to the low mathematical communication skills of students at UIN Alauddin Makassar. This identification was done by observing students' Mid-Semester Exam (UTS) answers in the calculus course. This initial step is important to ensure that the research remains focused and relevant to the institution's current needs (Rismawati et al., 2019). It also helps formulate research objectives and appropriate methodology (Ningrum & Leonard, 2015). The data obtained illustrate that the mathematical communication skills of Mathematics Education students at UIN Alauddin Makassar are still low. So, it is necessary to apply more innovative learning. In line with previous research, innovation in learning is important for developing student knowledge (Nilawati, 2022; A. A. Wulandari & Astutiningtyas, 2020). Innovative learning in this study is by implementing a getting offer learning design.

The learning design of getting-offer has four main steps, namely: 1) getting & offer, at this stage, students will be divided into five groups and will discuss the selection of materials for each group on the topic of derivatives; 2) reflection, at this stage students will choose their respective roles and conduct internal discussions related to the material then will convey the results of their discussions which are poured into learning videos; 3) showcase, students will conduct group presentations and Q&A between groups, then will connect ideas from feasible solutions; 4) integration, students will integrate the solutions obtained by applying mathematical software and provide feedback.

The learning tools used are the getting offer learning design guidebook, semester learning design, student worksheets, teaching modules, learning design implementation sheets, lecturer response questionnaires, student activity sheets, student response questionnaires, and communication skills tests.

The communication skills test created includes four indicators: 1) the ability to identify information, 2) the ability to express mathematical ideas, 3) the ability to use terms, notations, and structures, and 4) the ability to draw conclusions. Indicator 1 shows students' ability to identify information logically. This indicator appears in the discussion process both in and outside the classroom (Suhenda & Munandar, 2023). Indicator 2 shows that students can express what they hear well and provide relevant responses in question-and-answer sessions, so this is also evident in the student discussion process (Suhenda & Munandar, 2023). Indicator 3 uses various representations such as graphs, diagrams, or symbols using any media. Group presentations are a means to assess this aspect (Siregar, 2018). Indicator 4 describes the ability of students to work together in concluding, sharing ideas, and building shared knowledge

(Fatimah, 2016). Indicators 1-4 are included in the steps for solving students' mathematical communication ability test questions and are obtained from observation data on student activities during the discussion and learning process.

After the preparation of the learning devices, all learning devices were then validated by two experts. Instrument validation aims to determine the feasibility of an instrument and whether it is ready to use (Widiana et al., 2023). The study began by conducting a small-scale trial first outside the research sample. The trial was carried out three times at Unismuh, two trials involving two classes and YPUP involving 1 class in the mathematics education department. The first trial was carried out 5 times with the results of the analysis of the learning design device having met the practical criteria but not yet meeting the effective criteria. Improvement notes from the first trial stage were then used as material for improvement before conducting the second trial. The second trial was carried out 5 times, with the results of the analysis of the learning design device having met the criteria for practicality and effectiveness. The third trial was carried out 5 times, with the results of the analysis of the learning design device having met the criteria for practicality and effectiveness. The trial stage was carried out to help identify problems or errors that may not have been detected during the design stage (Triutami et al., 2024).

Next, the implementation stage of the research begins by giving a pretest, which aims to measure students' initial mathematical communication skills before treatment. After that, the implementation group was taught using the getting offer learning design, which involves group discussions, presentations, mathematical software use, and technology such as the Learning Management System (LMS) to support interactive learning. This method effectively increases student engagement and improves mathematical communication skills. These results are by the principles used in research related to the integration of educational technology, as stated by Mangaroska et al., (2021); Thompson, (2024); and Devanny Gumulya (2024), namely that the combination of various systems can improve classification accuracy compared to single data from one learning system.

After that, each implementation group will undergo a learning process of five meetings. Students will be invited to conduct group discussions in the first to fifth meetings. The implementation group will be taught according to the getting offer learning design. The implementation class learning design will determine the roles and responsibilities of each student so that the discussion process will be more focused. The posttest is carried out to evaluate changes in mathematical communication skills after treatment. Data from the implementation results and communication skills tests are then collected for analysis. Data analysis is carried out to see whether implementing the getting-offer learning design has met the criteria for practicality and effectiveness in improving students' mathematical communication skills. This analysis method aligns with standard practices in educational research to evaluate the effectiveness of interventions (Subri et al., 2022).

The results of the study showed that the getting offer learning design was able to provide a significant influence on improving students' mathematical communication skills. The implementation group that used this design experienced a higher increase in mathematical communication skills. A significant increase in the implementation class showed that the getting-offer learning design gave students more opportunities to develop their mathematical communication skills. This study's results align with Vygotsky's theory, which highlights the importance of the zone of proximal development in learning. The getting offer learning design with an emphasis on group collaboration succeeded in creating a zone of proximal development that allowed students to learn from peers and develop mathematical communication skills significantly (Bekirogullari, 2011;Xue, 2023; Aprilia Rahmawati & Putri Purwaningrum, 2022). The indicator of the use of representation in the implementation group showed the highest indicator of improvement. This is because, in learning, students use software to describe graphs and tables from the discussion material presented. Using software allows students to get an overview that provides a more precise understanding and focused communication skills. In line with this, other studies have shown that technology-based learning, such as MatLab, contributes positively to students' mathematical communication skills, indicating that an innovative approach to learning design can improve learning outcomes (N. Sari & Tanzimah, 2017).

Getting-offer emphasizes the active role of students in learning through discussion activities, presentations, and group problem solving. This active involvement encourages students to develop mathematical arguments more deeply, convey ideas more clearly, and improve understanding through interactions with fellow students and lecturers. In mathematics learning, mathematical communication includes conveying ideas verbally and students' ability to express mathematical ideas through writing, symbols, graphs, and diagrams (Anderha & Maskar, 2020). The results of this study align with the opinion of Mulbar et al., (2022) who stated that mathematical communication is an important skill in mathematics learning because it allows students to formulate, evaluate, and explain solutions to the problems they face. The getting-offer learning design supports students to practice conveying mathematical ideas in various ways to hone this ability effectively.

The getting-offer learning design allows students to choose discussion materials, play an active role in expressing opinions, and utilize mathematical tools or applications to support the presentation of learning materials. This freedom allows students to be more emotionally and intellectually involved in learning, which ultimately increases students' motivation and understanding of the material. Active student involvement is a key element in effective mathematics learning. The results of this study support this view by showing that students actively involved in learning experience a significant increase in mathematical communication skills (I. K. Sari et al., 2020). In addition, this study also supports previous findings from Biccard & Wessels (2011), which stated that active involvement in mathematical learning contributes to the development of mathematical communication skills of prospective mathematics teachers (Vale & Barbosa, 2023).

Getting-offer offers advantages in terms of flexibility and autonomy given to students in the learning process. Students can choose discussion topics according to their interests and understanding and express their solutions and thoughts freely. This allows them to develop critical thinking and mathematical communication skills simultaneously. This aligns with the view of Kamid et al., (2020) that an interactive and student-oriented learning process can help deepen understanding of mathematical concepts and strengthen communication skills.

Using the getting offer learning design shows that allowing students to participate in learning actively can improve mathematical understanding and communication skills. This improvement is very relevant for prospective mathematics teacher students because it is one of the main competencies teachers must have in explaining mathematical concepts to students clearly and effectively (Biccard & Wessels, 2011). In addition, the getting-offer learning design also provides space for lecturers to innovate in learning design by including elements of technology and supporting applications such as mathematical software. Technology can help students visualize complex mathematical concepts and support their ability to communicate mathematical ideas visually. The use of technology enhances the learning experience for students, both face-to-face and remotely, allowing real-time interaction between students and lecturers (Holmes & Prieto-Rodriguez, 2018).

Conclusion

The results of this study indicate that the learning design of getting-offer in higher education to improve communication skills has met the criteria of being valid, practical, and effective in improving mathematical communication skills. However, this study only involved a relatively small implementation class from one university, namely UIN Alauddin Makassar, so generalizing the results to a broader population still needs to be done. This study also focuses more on developing students' mathematical communication skills. So, re-analysis is required to apply learning design to classes with different materials and improve other abilities in future research.

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