

Mathematical Communication Ability in Problem Based Learning with STEAM Approach Viewed from Learning Styles

Aditya Hendra Prasetiawan^{1✉}, Zaenuri Mastur², dan Stevanus Budi Waluya³

^{1,2,3} Universitas Negeri Semarang, Indonesia

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Abstract

The purpose of this research is to analyze the quality of PBL learning with STEAM approach to mathematical communication abilities of 8th grade students at SMPN 1 Tonjong and to analyze mathematical communication abilities of 8th grade students at SMPN 1 Tonjong in PBL learning with STEAM approach viewed from learning style. The research method used is mix methods. The research design used is a sequential explanatory design. Sample selection used a cluster random sampling technique. The population in this study were 8th grade students at SMPN 1 Tonjong while the samples were 28 students of class 8A as the experimental class and 28 students of class 8C as the control class. Data collection methods include observation, test, interviews and documentation. Data analysis includes normality test, homogeneity test, classical completeness test, average difference test and proportion difference test. The results of this research show that mathematics learning with PBL model using a STEAM approach is on high quality for mathematical communication ability because fulfill valid, practical and effective criteria. The results of the qualitative analysis show that each learning style fulfill different indicators of mathematical communication ability. It is means that differences in students learning styles influence their mathematical communication ability.

Abstrak

Penelitian ini bertujuan untuk menganalisis kualitas pembelajaran PBL berpendekatan STEAM terhadap kemampuan komunikasi matematis siswa kelas 8 di SMPN 1 Tonjong dan menganalisis kemampuan komunikasi matematis siswa kelas 8 di SMPN 1 Tonjong pada pembelajaran PBL berpendekatan STEAM ditinjau dari gaya belajar. Metode penelitian yang digunakan adalah mix methods. Desain penelitian yang digunakan adalah sequential explanatory design. Pengambilan sampel menggunakan teknik *cluster random sampling*. Populasi dalam penelitian ini adalah siswa kelas 8 di SMPN 1 Tonjong sedangkan sampelnya adalah 28 siswa kelas 8A sebagai kelas eksperimen dan 28 siswa kelas 8C sebagai kelas kontrol. Metode pengumpulan data meliputi pengamatan, tes, wawancara dan dokumentasi. Analisis data meliputi uji normalitas, uji homogenitas, uji ketuntasan klasikal, uji beda rata-rata dan uji beda proporsi. Hasil penelitian menunjukkan pembelajaran matematika dengan model PBL berpendekatan STEAM berkualitas terhadap kemampuan komunikasi matematis karena memenuhi kriteria valid, praktis, dan efektif. Hasil analisis kualitatif menunjukkan masing-masing gaya belajar memenuhi indikator kemampuan komunikasi matematis yang berbeda. Hal tersebut berarti perbedaan gaya belajar siswa memengaruhi kemampuan komunikasi matematisnya.

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✉Alamat korespondensi:

Program Studi Pendidikan Matematika
Fakultas Keguruan dan Ilmu Pendidikan Universitas Muria Kudus
Kampus UMK Gondangmanis, Bae Kudus Gd. L. It I PO. BOX 53 Kudus
Tlp (0291) 438229 ex.147 Fax. (0291) 437198
E-mail: aditya25@students.unnes.ac.id

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INTRODUCTION

Mathematics is a science that has an important role in education (Wardono et al., 2020). Mathematics contributes to improving human thinking power (Yaniawati et al., 2019) and students ability to deal with problems. Therefore, mathematics is an important subject for students to learn at school (Setiawan et al., 2022). Kennedy & Sundberg (2020) stated that if students want to compete in the 21st century, they must have critical thinking, communication, collaboration, and creativity or known as 4C. Communication is an important process in mathematics learning (Vale I & Barbosa A, 2017). It is means that mathematical communication ability are very important for students to have in mathematics learning (Sugianto et al., 2022). Creating a learning environment that encourages mathematical communication is very important to achieve new goals in mathematics education (Kaya & Aydin, 2016). Mathematical communication is an important ability for students to express mathematical concepts through interaction and exchange of mathematical ideas between individuals (Yang et al., 2016).

The results of 2022 Program for International Student Assessment (PISA) survey in mathematics category show that Indonesia is in 70th position out of 81 countries with an average score of 366 (OECD, 2023). This average score decreased compared to 2018 where Indonesia obtained an average score of 379 in mathematics category, its means that the ability of Indonesian students in mathematics field is still low. Based on a preliminary study at SMPN 1 Tonjong, information was obtained that the majority of students were still unable to solve the questions given by the teacher correctly. This information is reinforced by the 2019 Ministry of Education and Culture National Examination score report where the average score for the national mathematics exam at SMPN 1 Tonjong is 47,21. Its means that students ability in mathematics subjects are still low, which one that mathematical communication ability are not optimal.

Teachers need to choose an appropriate and student-centered learning model to optimize students mathematical communication ability. According to Sudia & Muhammad (2020) Problem Based Learning (PBL) is a recommended learning model for optimizing students mathematical communication ability. PBL as a learning model are able to improve mathematical communication ability, in line with research results of Zakeus (2022) PBL provides

an increase in mathematical communication ability in the form of an increase in the average test score from cycle I to cycle II by 90.24%, namely from 40.196 to 76.47. Mirna et al. (2023) research show that the application of PBL in mathematics learning can improve mathematical communication ability with N-gain score of 0,34 which is included in the medium category.

The selection of learning models needs to be strengthened by learning approach. Choosing the right learning approach can develop mathematical communication ability (Prabawanto, 2019). One of approach that supports PBL learning is STEAM. According to Budiyo, Husna, & Wildani (2020) PBL with STEAM approach can be used as an alternative in learning and has a significant effect on students creative thinking ability with Fcount=177.189. The research results of Astuti, Mayasari, & Setyowati (2023) show that there is a strong influence of the PBL model with a STEAM approach on student learning outcomes in science subjects with an effect size of 1.802. There has not been much research on the application of PBL with a STEAM approach in mathematics learning. The STEAM approach is more often applied with the Project Based Learning (PjBL) model as in the research of Fitriyah & Ramadani (2021) where the PjBL model using STEAM approach has a significant effect on creative thinking skills with Fcount value of 35.551 and critical thinking skills with an Fcount value of 9.401. In Suciari, Ibrohim, & Suwono (2021) research, PjBL-STEAM has a positive effect on improving students communication ability with an average correction of 80.13 in the experimental class and 75.48 in the control class. Therefore, researchers are interested in integrating the PBL model with a STEAM approach in mathematics learning to improve students mathematical communication ability.

Except the selection of learning models and approach, there are affective aspects that affect students mathematical communication ability namely learning styles (Fitriana, Isnarto, & Prabowo, 2018). Classifying students' learning styles is something that needs to be done because by knowing students' learning styles, teachers can solve students' problems and prepare students' skills in everyday life (Nasir, Mughal, & Rind, 2021). The types of learning styles in this research follow the classification according to DePorter & Hernacki (2015), namely visual (v), auditory (a), and kinesthetic (k). According to research by Danaryanti & Noviani (2015), mathematical communication abilities of 7th

grade students with a visual learning style are higher than students with auditory and kinesthetic learning styles, as seen from the average score of their mathematical communication ability and the students final scores in solving mathematical essay questions. This is in line with research by Suzana, Zaiya, & Nurfazillah (2023) that students with a visual learning style have mathematical communication ability at high level with percentage of 88,88%, students with an auditory learning style have mathematical communication ability at medium level with percentage of 50% and students with kinesthetic learning style have mathematical communication ability at a medium level with percentage of 66,66%.

Based on the description above, the research question in this study namely (1) how is the quality of PBL with STEAM approach towards mathematical communication ability of 8th grade students at SMPN 1 Tonjong and (2) how is the mathematical communication ability of 8th grade students at SMPN 1 Tonjong in PBL with STEAM approach viewed from learning styles. The purpose of this research is to (1) analyze the quality of PBL with STEAM approach towards mathematical communication abilities of 8th grade students at SMPN 1 Tonjong and (2) analyze the mathematical communication ability of 8th grade students at SMPN 1 Tonjong in PBL with STEAM approach viewed from learning styles.

RESEARCH METHODS

The research method used is mix methods. The research design used by researchers is a sequential explanatory design. The first stage was carried out with quantitative research and the second stage was carried out with qualitative research. Quantitative methods play a role in obtaining measurable quantitative data which can be descriptive, comparative and associative, while qualitative methods play a role in proving, deepening, expanding, weakening and disproving quantitative data that has been obtained at an early stage. Data collection methods include observation, tests, interviews and documentation. Quantitative data analysis includes (1) normality test, (2) homogeneity test, (3) classical exhaustiveness test, (4) average difference test and (5) proportion difference test. Qualitative data analysis includes (1) data condensation, (2) data presentation and (3) drawing conclusions. The credibility of qualitative data was tested using triangulation techniques (Nuha, Waluya, & Junaedi, 2018).

The research steps carried out by the researcher were determined the research population, namely 8th grade students at SMPN 1 Tonjong. Next, using the cluster random sampling technique, the researcher chose the research sample, namely 28 students of class 8A as the experimental class and 28 students of class 8C as the control class. The researcher then compiled learning tools including syllabus, lesson plans and worksheets as well as research instruments including mathematical communication tests, learning style classification questionnaires, observation sheets on the implementation of learning models, student response questionnaire sheets and interview guidelines. The learning tools and research instruments then validated by expert validators. The researcher then classified learning styles and implemented PBL learning using a STEAM approach in the experimental class. Next, the experimental class and control class were given a mathematical communication ability test.

Researchers then conducted interviews with research subjects to determine mathematical communication ability based on learning styles. Research subjects were selected by purposive sampling technique. Researchers determined 9 students as research subjects for analysis of the level of mathematical communication ability based on visual (v), auditory (a) and kinesthetic (k) learning styles where each learning style was represented by 3 students. The nine students then observed for their mathematical communication ability and interviewed the nine students. The selection of subjects depends on the researchers themselves, depend on uniqueness findings in the research.

RESULTS AND DISCUSSION

To find out the quality of PBL learning with the STEAM approach, researchers paid attention to 3 indicators, namely (1) validity, (2) practicality and (3) effectiveness. The quality of learning is reviewed quantitatively and qualitatively. Indicators of mathematical communication ability in this research include: (1) the ability to write down what is known and asked about a problem; (2) the ability to connect everyday events with language or mathematical symbols or other visual forms in presenting mathematical ideas; (3) the ability to understand and evaluate mathematical ideas in solving problems systematically and correctly; and (4) the ability to express conclusions regarding answers to problems according to the question.

Quantitatively, learning is categorized on high quality if the learning model used is

effective, namely (1) students mathematical communication ability in PBL with STEAM approach reach completeness classical; (2) the average of students mathematical communication ability in PBL with STEAM approach is better than the average of students mathematical communication ability in PBL; (3) the proportion of students mathematical communication ability in PBL with STEAM approach is more than the proportion of students mathematical communication ability in PBL.

Based on the results of classical completeness test obtained $z_{\text{count}} = 1,80 > 1,64 = z_{0,45}$. Its means that the proportion of completeness mathematical communication test results in PBL with STEAM approach is more than 75%. So students' mathematical communication abilities in PBL with STEAM approach reach completeness classical. This is in accordance with Angga (2022) that PBL-STEAM has an impact on 90% of students obtaining scores above the KKM. The average difference test results show that $t_{\text{count}} = 2,28 > 1,68 = t_{(0,95)(54)}$. Its means that the average of students' mathematical communication abilities in PBL with STEAM approach is better than the average of students mathematical communication ability in PBL. The different proportion test results obtained $z_{\text{count}} = 2,96 > 1,64 = z_{0,45}$. Its means that the proportion of students' mathematical communication abilities in PBL with STEAM approach is more than the proportion of students' mathematical communication abilities in PBL. Based on these three things, it means that PBL model with STEAM approach is effective improving mathematical communication ability.

Qualitatively, learning is said to be of good quality if (1) the validation results of learning tools and research instruments are in the valid criteria with good minimum category and (2) the results of observations in learning process implementation meet practical criteria with minimum good category and the number of students who give positive responses reaches 75%. Researchers made learning tools consisting of syllabus, lesson plans, student worksheets, mathematical communication ability test, interview guide, observation of learning implementation, student response questionnaire and learning style test. Learning tools that have been made then validated by the validator. Based on the validators assessment, the results were obtained: (1) the average score for the syllabus was 4,75; (2) the average score for lesson plans is 4,8; (3) the average score for student worksheets is 4,65; (4) the average score for mathematical communication ability test is 4,65;

(5) the average score for the interview guide was 4,65; (6) the average score for observing learning implementation is 4,7; (7) the average score for the student response questionnaire is 4,6 and (8) the average score for the learning style test is 4.75. Its can be concluded that the validity indicator meets valid criteria. This complements the research by Sabara et al. (2022) that the average validation score for lesson plans is 96%, LKPD is 97% and test questions are 97%.

Observation of learning process implementation involved 1 mathematics teacher at SMPN 1 Tonjong. Based on the results of observations of the implementation of the learning process from the first meeting to the third meeting, it can be seen that the average score resulting from observations of the implementation of the learning process is 4.9 with a score percentage of 98.3 which is in the very good criteria. This is in line with Angga (2022) research that PBL-STEAM learning is carried out in a very good category. While the results of student response questionnaires can be seen that 85% of students responded with positive criteria. Most students consider PBL with STEAM approach as an interesting new learning model and approach. This is in accordance with the research of Suriyana & Novianti (2021) that in general student responses to STEAM-based learning are in the positive category. Based on these two things, it can be said that PBL model with STEAM approach is quality learning.

Based on tests and interviews with a visual learning style students, it was found that students were able to solve mathematical communication problems well. In 1st indicator of mathematical communication ability, students with visual learning style are able to write down the information they know and ask about a problem. This is in line with research by Anintya, Pujiastuti, & Mashuri (2017) that students with visual learning style can write down the information they know and ask questions about the questions being analyzed. In 2nd indicator of mathematical communication ability, visual learning style students are able to create visual forms in presenting mathematical ideas. This is in accordance with research by Disty, Walid, & Hartono (2021) that students with a visual learning style are able to describe mathematical ideas in written or visual form. In 3rd indicator of mathematical communication

ability, visual learning style students are less able to solve problems systematically and correctly. This is in accordance with research by Anintya, Pujiastuti, & Mashuri (2017) that students with a visual learning style are less able to solve everyday problems in writing. In 4th indicator of mathematical communication ability, visual learning style students are able to write answer conclusions. This is in line with research by Disty, Walid, & Hartono (2021) that students with a visual learning style can write conclusions according to questions. This means that students with visual learning style fulfill 3 of 4 indicators of mathematical communication ability.

Based on tests and interviews with an auditory learning style students, it was found that students were able to solve mathematical communication problems well but not optimally. In 1st indicator of mathematical communication ability, students with an auditory learning style are able to write down the information they know and ask questions. This is in accordance with the opinion of Anintya, Pujiastuti, & Mashuri (2017) that students with an auditory learning style can write down the information they know and ask about the questions being analyzed. In 2nd indicator of mathematical communication ability, students with an auditory learning style are able to create visual forms in presenting mathematical ideas. This is in accordance with research by Disty, Walid, & Hartono (2021) that students with an auditory learning style are able to describe mathematical ideas in written or visual form. It is also in accordance with research Kurniawati, Suyitno, & Mulyono (2021) that students with an auditory learning style can assume everyday events using mathematical symbols. In 3rd indicator of mathematical communication ability, students with an auditory learning style are less able to solve problems systematically and correctly. This is in line with the opinion of Anintya, Pujiastuti, & Mashuri (2017) that students with an auditory learning style are less able to solve everyday problems in writing. In 4th indicator of mathematical communication ability, an auditory learning style students are less able to write answer conclusions. This is in line with research by

Anintya, Pujiastuti, & Mashuri (2017) that students with an auditory learning style are less able to write conclusions according to questions. This means that students with an auditory learning style fulfill 2 of 4 indicators of mathematical communication ability.

Based on tests and interviews with a kinesthetic learning style students, it was found that students were able to solve mathematical communication problems well. In 1st indicator of mathematical communication ability, kinesthetic learning style students are able to write down information that is known and asked about a problem. This is in accordance with the opinion of Anintya, Pujiastuti, & Mashuri (2017) that kinesthetic learning style students can write down the information they know and ask about the questions being analyzed. In 2nd indicator of mathematical communication ability, kinesthetic learning style students are able to create visual forms in presenting mathematical ideas. This is in accordance with research by Anintya, Pujiastuti, & Mashuri (2017) that students with a kinesthetic learning style are able to describe mathematical ideas in written or visual form. In 3rd indicator of mathematical communication ability, kinesthetic learning style students are less able to solve problems systematically and correctly. This is in accordance with research by Disty, Walid, & Hartono (2021) that students with a kinesthetic learning style are less able to solve everyday problems in writing. In 4th indicator of mathematical communication ability, kinesthetic learning style students are able to write answer conclusions. This is different from research by Kurniawati, Suyitno, & Mulyono (2021) that students with a kinesthetic learning style cannot write conclusions according to the question. This means that kinesthetic learning style students fulfill 3 of 4 indicators of mathematical communication ability.

Based on the discussion above, students with an auditory learning style need to receive more attention in learning mathematics compared to visual and kinesthetic learning styles so that the mathematical communication ability of students with an auditory learning style can improve.

CONCLUSION

Based on the research results and discussions that have been described, the following conclusions are obtained. Mathematics learning using PBL model with STEAM approach is on high quality for mathematical communication ability. This is shown by (1) validity indicators fulfill valid criteria, (2) practicality indicators fulfill practical criteria and (3) effectiveness indicators fulfill effective criteria. This means that the PBL model with STEAM approach can be used as an alternative and reference for mathematics learning in schools to improve mathematical communication ability.

Based on the analysis of mathematical communication ability viewed from learning style, it can be concluded that students with visual learning style can write down what is known and asked about a problem, can connect daily events with language or mathematical symbols or other visual forms in presenting mathematical ideas, and can express conclusions regarding answers to problems according to questions. Auditory learning style students can only write down what is known and asked about a problem and connect daily events with language or mathematical symbols or other visual forms in presenting mathematical ideas. Students with kinesthetic learning style can write down what is known and asked about a problem, can connect everyday events with language or mathematical symbols or other visual forms in presenting mathematical ideas, and can express conclusions regarding answers to problems according to questions. For further research, it is necessary to measure the influence of PBL model with STEAM approach on mathematical communication ability as well as the influence of learning styles on mathematical communication ability.

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