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# Development of Stem-Based Mathematics Learning Modules with The PBL Model to Improve Mathematical Communication Ability

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**ABSTRACT**

The research aims to develop a learning module that employs a STEM–integrated PBL framework to strengthen the mathematical communication proficiencies of secondary school learners. Its attributes encompass being sound, functional, and productive. The methodology adopted in this study is the R&D approach, utilising the ADDIE framework for development, which encompasses analysis, design, development, implementation, and evaluation. The subject pool for this research comprised the entirety of the 30 students enrolled in class VII at Muhmmadiyah 7 Medan Junior High School. The study's findings indicated that the learning module's validity assessment placed it within the highly valid spectrum, with an average score of 87,41%. Furthermore, the assessment of the learning module's practicality, derived from teacher questionnaires, placed it in the highly practical category with a 95% rating, while student questionnaires yielded an 86,14% rating, also denoting a highly practical standing. Additionally, the post-test outcomes revealed an enhancement in students' mathematical communication prowess, marked by a 77,58% surge, thus categorising it as effective. Hence, the learning module, integrating the STEM-based PBL model to elevate Junior High School Students' Mathematical Communication Skills, demonstrates both practicality and effectiveness.



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## 1. INTRODUCTION

Mathematics is an influential subject in the world of education. Mathematics in education is a learning process that enables students to develop critical, logical, and analytical thinking skills through an understanding of mathematical concepts. Mathematics is the study of abstract and logical concepts about numbers, space, and structures to solve problems and understand natural phenomena [1]. The objectives of mathematics learning

include developing critical thinking, problem-solving, and creative thinking skills, as well as understanding scientific concepts [2].

The 21st-century education demands that students possess critical thinking and creativity, the ability to collaborate, and the ability to communicate effectively. Communication skills, particularly in mathematics, are crucial for conveying ideas, understanding concepts, and solving mathematical problems effectively. However, many students still struggle to express their mathematical thinking verbally and in writing. In mathematics learning, mathematical communication plays a crucial role in every learning process because communication is fundamental to the learning process [3].

Communication skills are essential to 21st-century learning. The importance of mathematical communication skills is highlighted in research by Afri and Rahmadani [4], which asserts that these skills are essential for helping students thrive in their learning journey. The purpose of mathematical communication is to foster an environment where students articulate and exchange their mathematical thoughts and insights. Furthermore, proficiency in mathematical communication can have a broad impact, touching various facets of everyday existence [5]. The indicators of students' mathematical communication abilities are writing (write), drawing (drawing), and mathematical expression (mathematical expression) [6].

In PISA questions, communication skills are one of the important aspects assessed. This relates to the seven basic mathematical skills in the PISA framework developed by the Organisation for Economic Co-operation and Development (OECD). The skills identified by the Organization for Economic Co-operation and Development (OECD) consist of interacting through language (communication), employing mathematical thinking (mathematizing), expressing concepts (representation), constructing logical thought processes and validations (reasoning and argument), creating approaches to tackle challenges (devising strategies for solving problems), utilizing specialized vocabulary, structures, and processes (using symbolic, formal and technical language and operations), and implementing calculating instruments (using mathematical tools) [7].

Previous research has shown that students' mathematical communication skills during mathematics learning remain relatively low. Yulianti, Purnama, and Hidayat [8] found that students' mathematical communication skills in linear equations and inequalities with a single variable reached only 54%. Furthermore, research conducted by Anisa et al [9] showed that students' mathematical communication skills in social arithmetic were only 32.81%. Similarly, Siti and Depriwana [10] found that students' mathematical communication skills in quadrilaterals and triangles only reached 45.73%. Based on these findings, it can be concluded that students' mathematical communication skills across various mathematical materials remain low.

Based on initial observations, questions were given to assess students' mathematical communication skills, covering topics such as Triangles and Quadrilaterals. The researcher's observations: The results showed that students' mathematical communication skills in this material remained relatively low. This was evident from the various errors students made in answering the questions given. Based on the errors students made in the

table above, it can be concluded that their mathematical communication skills remained relatively low.

The researcher's findings indicate that teaching still relies heavily on lectures, making the teacher the main focus. This way of teaching can negatively affect how well students can communicate about math. As a result, students do not develop strong math communication skills. This is clear because students struggle to give clear and organised reasons, which makes them less involved in learning. This lines up with what Deswita et al. [11] found in their research, which says that students struggle to share their thoughts about math effectively. Students have trouble putting their thoughts into words when teachers ask questions, so the teacher stays the centre of attention, and students cannot turn problems into symbols, pictures, or math equations. Because of this, the methods and examples that teachers choose have a significant impact on how well students learn to talk about math.

To boost students' abilities to communicate mathematically, a number of different educational strategies and frameworks can be implemented. One pertinent method involves the STEM framework. According to Mulyani's research [12], the STEM method combines four key fields—science, technology, engineering, and mathematics—in an educational setting that addresses real-world challenges. Meanwhile, Sartika [13] stated that the STEM approach aligns with the 2013 Curriculum because both aim to develop students' attitudes, knowledge, and skills. Handayani [14] also emphasised that STEM is an important form of learning in the modern era because it aims to develop human resources with the ability to think critically, logically, systematically, and rationally. Thinking about facing global challenges. Therefore, the STEM approach to learning is believed to improve students' mathematical communication skills. In addition, the STEM approach is often combined with problem-solving-focused learning models, such as the Problem-Based Learning (PBL) model. Susanto [15] explains that PBL is a learning model that uses real-life problems to help students develop higher-order thinking skills. Ariani and colleagues [16] add that STEM-based learning implemented through the PBL model is an integrated approach that involves elements of science, technology, engineering, and mathematics to improve students' thinking skills through contextual problem-solving. Thus, the problem-based learning model can stimulate students to think deeply and analytically.

The STEM approach combined with the Problem-Based Learning (PBL) model is believed to develop students' higher-order thinking skills. This belief is supported by previous research by Mustofa and colleagues, which showed that implementing STEM-based learning through the PBL model in science subjects improved students' higher-order thinking skills [17]. Based on these results, this study aims to apply a similar approach to mathematics learning.

The selection of learning methods in accordance with has a significant influence on achievement, communication skills, and mathematical skills. However, these abilities will not develop optimally with methods alone; they also require the support of supporting facilities. One such facility in the learning process is a module. According to Sukiman [18], a module is a systematic and engaging teaching resource that encompasses content, materials, learning strategies, and evaluation, which enables students to learn

independently. Similarly, Suastika and Rahmawati [19] stated that modules are an important component because they facilitate students' access to important information from the subject matter. Therefore, the use of modules is expected to help students better understand the material and increase their independence in learning. Previous research also shows that STEM-based modules can improve students' communication and critical thinking skills in mathematics. Research by Mulyanto shows that students who learn through STEM modules demonstrate significant improvements in their mathematical communication skills [20].

Based on the description previously, Researchers are encouraged to develop STEM-based learning modules combined with Problem-Based Learning (PBL) models to support teachers in the learning process and make it easier for students to understand the subject matter. The STEM approach, combined with the PBL model, is expected to help students face challenges. Furthermore, solve contextual problems to help them practice high-level thinking skills.

Several previous studies have examined similar topics, including one conducted by Putri [21], who developed a Mathematics Learning Module on similarity and congruence. Unlike those studies, this study will focus on developing a printed learning module covering equivalent and inverse comparisons.

Based on this description, the researcher will conduct a study titled "Development of STEM-Based Mathematics Learning Modules With The PBL Model To Improve Mathematical Communication". Ability Study aims to make a positive contribution to the world of education, especially in developing practical, effective teaching materials that address current learning needs.

## 2. METHOD

The methodology employed in this study is based on Research and Development (R&D). This method is focused on the creation and advancement of a specific product [22]. During the study, the research team employed the ADDIE development model, which stands for Analysis, Design, Development, Implementation, and Evaluation. Conceived by Reiser and Mollenda during the 1990s, the ADDIE model offers a framework for creating learning tools that are effective, flexible, and conducive to enhancing performance. Therefore, instructors can use this model to aid in organising the educational process and learning experiences [23].

This study used three stages of data collection to determine the feasibility of piloting the learning module with seventh-grade students at SMP Muhammadiyah 7 Medan. The three stages included a validation sheet to assess the validity of the developed learning module, which was evaluated by four validators comprising three lecturers and one teacher. The next stage was distributing student and educator response questionnaires to test the practicality of the learning module. The final stage was administering pretests and post-tests to test the module's effectiveness.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

This research and development was conducted at SMP Muhammadiyah 7 Medan to assess the validity, practicality, and effectiveness of the learning module using the STEM-based PBL model. The module has undergone validation by experts and practitioners. The resulting product is a learning module using a STEM-based PBL model on the subject of comparing values and their inverses, created to help students in seventh grade of junior high enhance their abilities to communicate mathematically. This study employs Research and Development (R&D) as its method, utilising the ADDIE model for development purposes. The central aim of this research is to create a module focusing on the subject of probability. As explained in the previous chapter, the following will describe each stage in the ADDIE model:

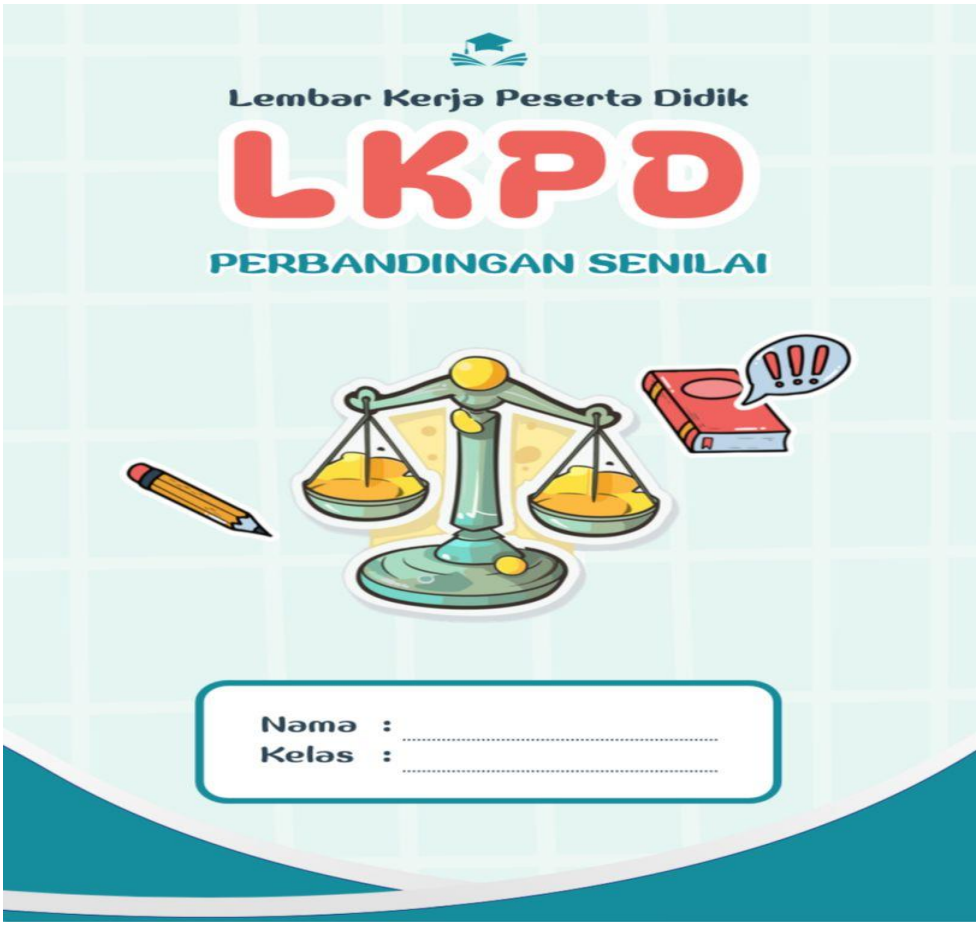
**Analysis stage:** This study includes curriculum analysis, material analysis, and media analysis. A curriculum analysis was conducted to determine the curricula used in schools. Information obtained from mathematics teachers at SMP Muhammadiyah 7 Medan indicated that they use an independent curriculum for mathematics learning. The material analysis stage covers students' needs in learning mathematics, especially the material on comparisons of value and inverse values. The material on comparisons of value and inverse values developed in this learning module, using the STEM-based PBL model, aligns with the learning indicators. The media analysis stage is needed to support the success of the media that will be developed. The process of analysing media involves determining which type is most appropriate for students.

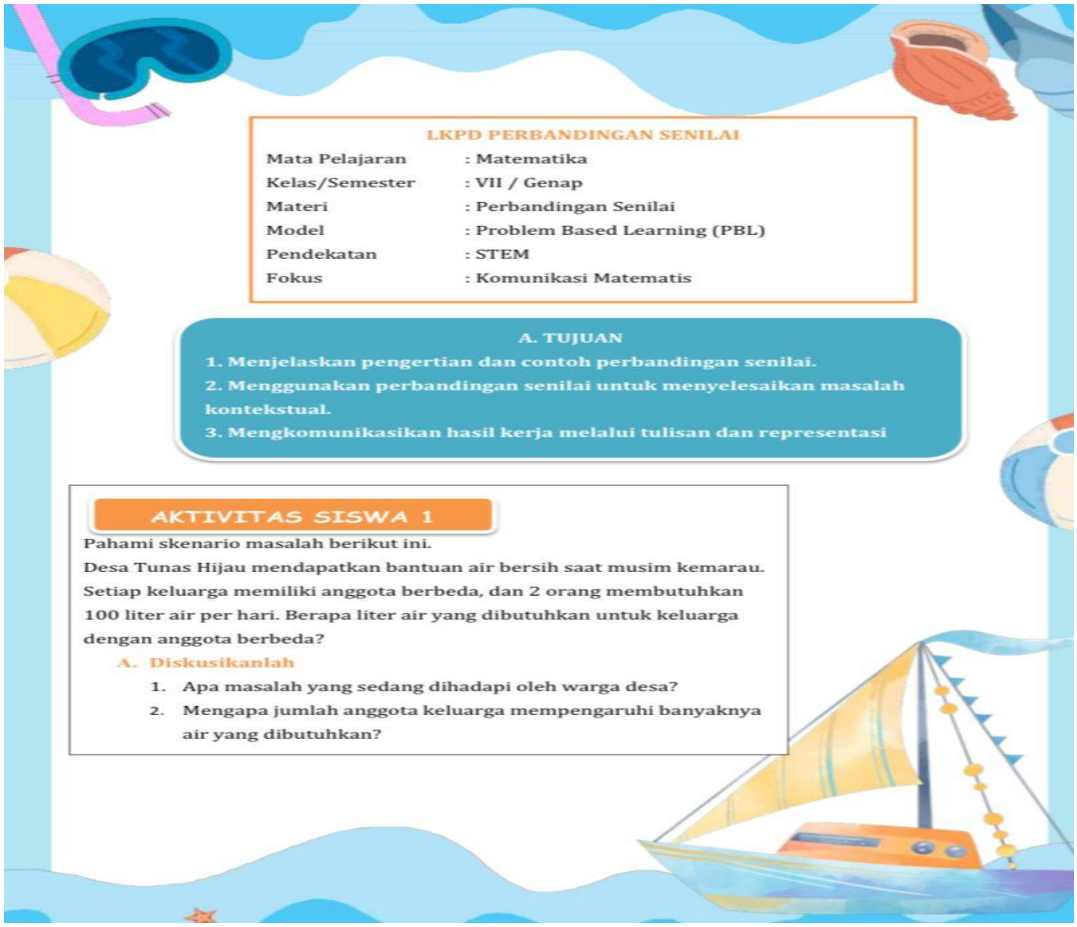
**Design stage:** This stage consists of compiling a learning module that produces a title for a mathematics learning module using a STEM-based PBL model for class VII of SMP Muhammadiyah 7 Medan on the subject of comparing values and inverse values. This is then continued by compiling the learning module design. The module structure is presented sequentially, starting with the cover page and the introduction section, which includes a brief description, basic competencies, and instructions for using the module. Next, the learning activities section, glossary, and ending with bibliography are compiled. Continued preparing the learning module instrument design; in compiling the learning module instrument design, research instruments are first developed. The learning module instrument design will inform revisions to the learning module product using a STEM-based PBL model to improve students' mathematical communication skills. It will serve as a tool for validating material experts, media experts, language experts, and practitioner experts.

**Development Stage:** The validation of the learning module product using the STEM-based PBL model was tested by 4 validators, including 3 lecturers at UIN North Sumatra and 1 subject teacher. The researcher distributed questionnaires to 4 validators to test the validity of the learning module, including material experts, media experts, linguists, and practitioner experts. Based on validation by material experts, an average of 82.14% was obtained, indicating a very valid category. Validation by media experts obtained an average of 85%, indicating a very valid category. Linguist validation yielded an average of 92.5%, indicating a very valid category. Following this,

verification by professionals in the field achieved an average score of 95%, which confirms that the category is highly valid. The total mean value derived from the group of four verifiers reached 88.92%, which led to the determination that this educational unit is highly legitimate and appropriate for application in instruction. Considering the outcomes of the authentication procedure that has been performed, the designed teaching unit can be classified as falling within the valid range, but still requires revision according to input and comments from the validators.

**Implementation Stage**: This stage is a practicality testing process conducted using a questionnaire administered to mathematics teachers and students. Based on the teachers' questionnaire results, the module was rated "Very Practical" with a 95% score. Meanwhile, the results of the practicality test, as measured by the student response questionnaire, were rated Very Practical, with an 86.14% score. This suggests the module's user-friendliness, engaging nature, and potential to help students improve their ability to communicate mathematical concepts effectively. Therefore, it can be inferred that this instructional module is suitable for application in educational settings. Figure 2 shows some of the contents of this module development.





**LKPD PERBANDINGAN SENILAI**

| | |
|---|---|
| Mata Pelajaran | : Matematika |
| Kelas/Semester | : VII / Genap |
| Materi | : Perbandingan Senilai |
| Model | : Problem Based Learning (PBL) |
| Pendekatan | : STEM |
| Fokus | : Komunikasi Matematis |

**A. TUJUAN**

1. Menjelaskan pengertian dan contoh perbandingan senilai.
2. Menggunakan perbandingan senilai untuk menyelesaikan masalah kontekstual.
3. Mengkomunikasikan hasil kerja melalui tulisan dan representasi

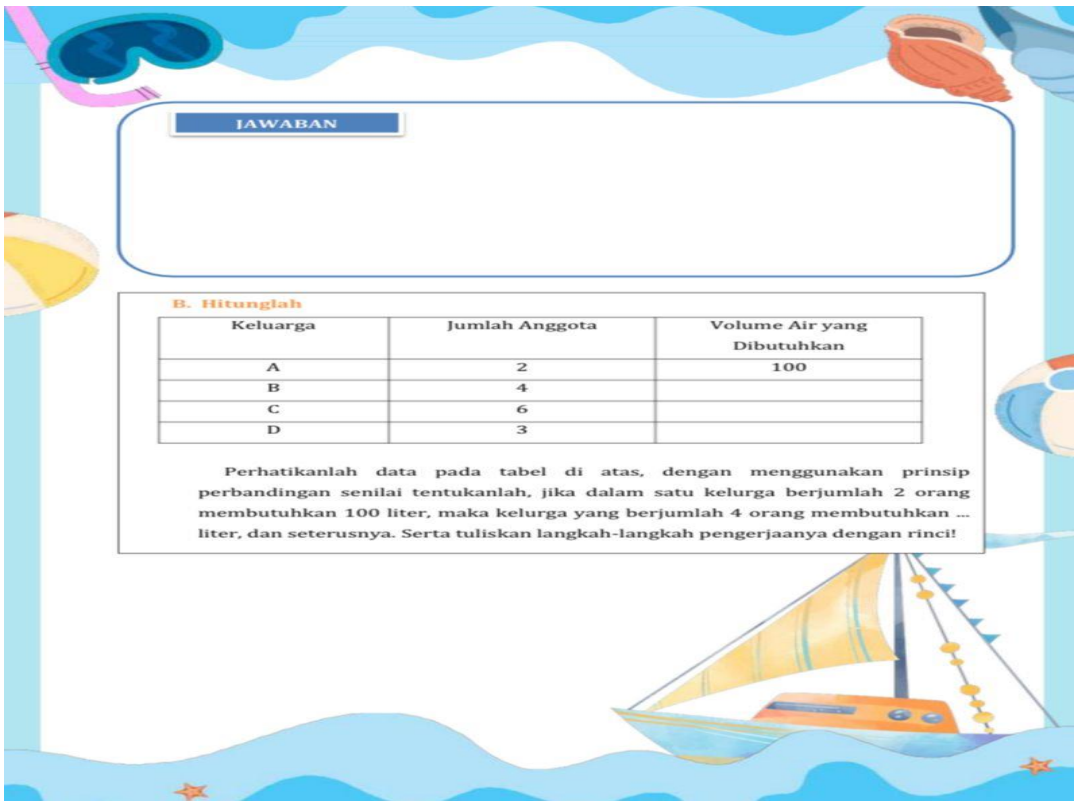
**AKTIVITAS SISWA 1**

Pahami skenario masalah berikut ini.

Desa Tunas Hijau mendapatkan bantuan air bersih saat musim kemarau. Setiap keluarga memiliki anggota berbeda, dan 2 orang membutuhkan 100 liter air per hari. Berapa liter air yang dibutuhkan untuk keluarga dengan anggota berbeda?

A. Diskusikanlah

1. Apa masalah yang sedang dihadapi oleh warga desa?
2. Mengapa jumlah anggota keluarga mempengaruhi banyaknya air yang dibutuhkan?



**JAWABAN**

B. Hitunglah

| Keluarga | Jumlah Anggota | Volume Air yang Dibutuhkan |
|---|---|---|
| A | 2 | 100 |
| B | 4 | |
| C | 6 | |
| D | 3 | |

Perhatikanlah data pada tabel di atas, dengan menggunakan prinsip perbandingan senilai tentukanlah, jika dalam satu kelurga berjumlah 2 orang membutuhkan 100 liter, maka kelurga yang berjumlah 4 orang membutuhkan ... liter, dan seterusnya. Serta tuliskan langkah-langkah pengerjaanya dengan rinci!

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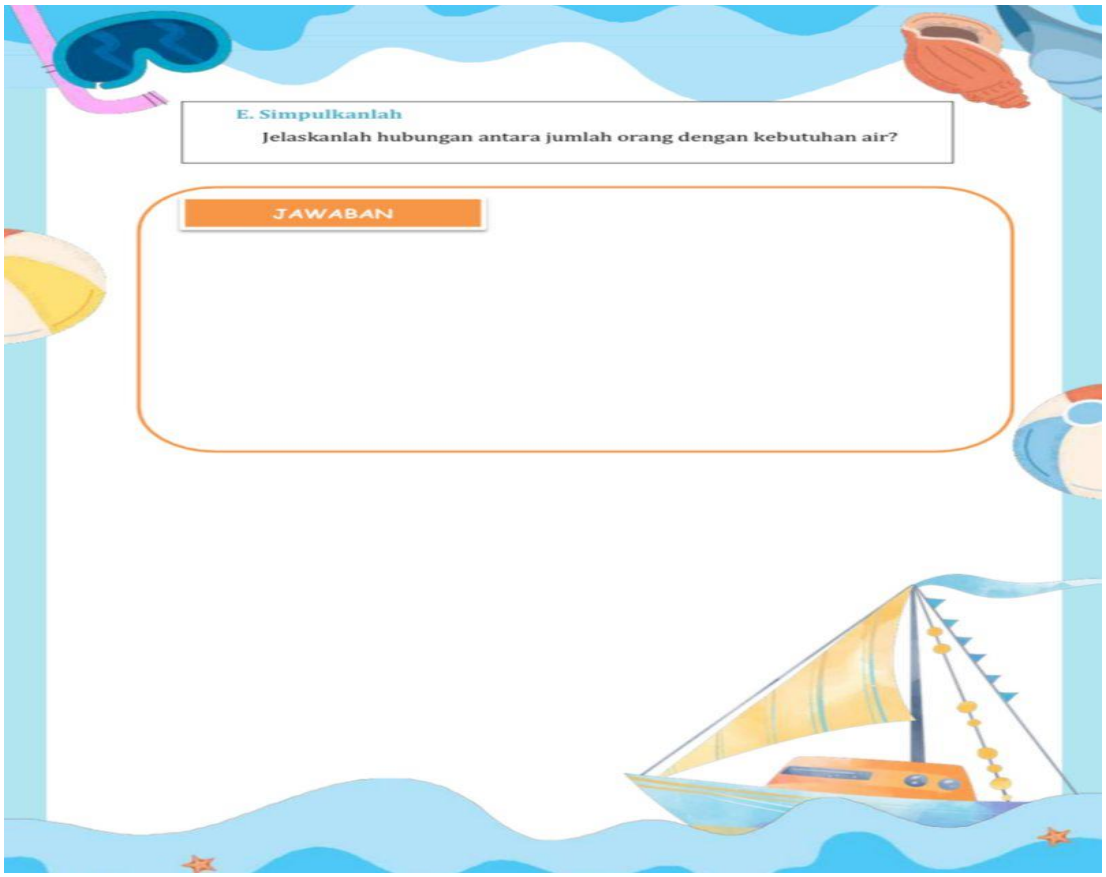


Figure 1. Learning Module Section

**Evaluation Stage:** aims to assess the extent of achievement of the learning module using the STEM-based PBL model to improve students' mathematical communication skills. At this stage, an effectiveness test was conducted, measured through student learning outcomes using pretest and post-test assessments. This measurement was also intended to determine whether students' problem-solving abilities had increased. Furthermore, to determine the increase in students' problem-solving abilities, the N-gain formula was used, yielding a value of 77.58%, indicating that problem-solving abilities had increased to a high level. Thus, this learning module is feasible and ready for use in the learning process.

### 3.2. Discussion

This research resulted in the development of a learning module using the STEM-based PBL model to improve seventh-grade students' mathematical communication skills in junior high school. In its use, the material in this learning module covers comparisons of values and their inverses. The resulting learning module is supported by images, comprehensive material on probability, and problems, enabling students to engage actively in learning activities.

This learning module was developed using the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation. This study used the ADDIE model because of its systematic stages. The ADDIE development model is

systematic and sequential. Each stage is carried out based on the previous one, ensuring continuity and leading to an improvement process before continuing the production stage of learning media, which is ready for testing.

Based on interviews with mathematics teachers at SMP Muhammadiyah 7 Medan, it was discovered that conventional methods still dominate the learning process. This causes students to become highly dependent on teachers and less active during learning activities. As a result, they struggle to construct understanding independently and are unable to solve math problems effectively. The learning media used are also limited, generally only using textbooks and aids in the form of objects around the school. Furthermore, it was revealed that students' problem-solving abilities at the school are still low. Students require considerable time to complete problem-solving tasks because they have difficulty understanding and interpreting the teacher's questions.

The analysis stage is the initial step in this research. In this stage, we observe and identify existing problems in mathematics learning activities and recognise the importance of developing learning modules. This stage is carried out through curriculum analysis, material analysis, and media analysis. In the curriculum analysis stage, learning materials are identified by examining the Basic Competencies (KD), which help formulate indicators to be achieved in accordance with the learning objectives. Next, the material analysis stage involves identifying opportunity materials to include and develop. Then, the media analysis stage determines the type of media to be developed; in this study, the media type is a learning module with a STEM-based PBL model.

Next is the design stage. At this stage, the developer determines the learning objectives, designs the sequence of materials, arranges learning activities using the STEM-based PBL model, and selects appropriate assessment instruments. In the context of the material on the comparison of value and inverse value, learning activities can be designed so that students explore these concepts through STEM. The module is designed not only to present abstract concepts but also to include exploratory STEM activities. The use of visual illustrations, STEM studies, and contextual problems will help students better understand the material and realise that mathematics is present in their daily lives.

The development stage is the concretisation of the design. At this stage, the module begins to be written in a complete draft, including an introduction, learning objectives, material descriptions, sample questions, practice questions, and self-reflection. Module developers systematically organise content, using communicative language and engaging visualisations, and incorporating STEM-related information. Next, the module is validated by mathematics subject matter experts, media experts, linguists, and practitioners to assess the appropriateness of the content, learning approach, and cultural accuracy. Input from the validators is used to refine and perfect the module before it is used in learning.

Once the module is deemed feasible, the next stage is implementation, where the module is directly applied in the learning process. Teachers use the module as a guide for teaching equivalent comparisons and inverse values, and students learn using teaching materials that incorporate a STEM context. In this stage, teachers act as facilitators, helping students explore and understand mathematical concepts through a STEM-based

PBL model. Students engage in group discussions on simple experiments and STEM-based analysis. Thus, students not only understand the concepts of equivalent comparisons and inverse values theoretically, but also see them applied in their real lives. This implementation also serves to observe students' responses to the learning module and identify its strengths and weaknesses in the classroom.

The final stage is evaluation, which assesses the module's overall effectiveness and quality. Evaluation takes two forms: formative and summative. Formative evaluation using a pretest is conducted during the development and implementation process to identify and correct deficiencies. A summative post-test is conducted after the entire learning process is completed to assess the impact of module use on students' understanding of the concept of opportunity, problem-solving skills, and attitudes toward North Sumatran culture. The evaluation results are used as the basis for the module's final revision and further development for broader use.

The research results concluded that this learning module is practical because it can be used without teacher assistance, giving students flexibility in their learning. Furthermore, the consistent, unambiguous presentation format and clear navigation within the ethnomathematics-based learning module significantly contribute to a positive, productive learning experience for students.

The findings of this study also align with trends in mathematics education innovation [24], which emphasise the importance of personalised learning and the integration of local contexts into teaching materials. Research by Mulyanto showed that students who learned using the STEM module showed significant improvements in their mathematical communication skills. The evaluation results in this study support the opinion [25] that the application of the ADDIE model in developing learning media has proven effective in producing high-quality learning products that meet student needs. Therefore, integrating the ethnomathematics approach and the ADDIE development model in this module is a strategic step towards realising meaningful, adaptive, and relevant learning that meets today's educational challenges.

## 4. CONCLUSION

The findings of this study indicate that the STEM-based learning model integrated with Problem-Based Learning (PBL) is valid, practical, and effective for mathematics instruction. The developed model successfully enhances students' mathematical communication skills, particularly in expressing ideas, using appropriate representations, and providing coherent reasoning in problem solving. In terms of implications, the STEM-PBL model can serve as a relevant alternative to improve the quality of mathematics learning in schools. Teachers may use this model to promote collaboration, creativity, and connections between mathematical concepts and real-life contexts. This study has limitations, including a small sample size and a limited scope of learning materials, which may affect the generalizability of the findings. Future research is recommended to involve larger, more diverse samples, explore additional mathematical topics, and develop a broader range of instructional materials. Overall, this study contributes to educational practice by offering a learning model that strengthens students' mathematical

communication abilities and supports the development of numerical literacy within the broader community.

## REFERENCES


[1] OECD. 2018. PISA 2015. *PISA Result in Focus*. Paris: PISA-OECD Publishing.

[2] UNESCO. (2018). *Digital literacy and beyond*. UNESCO EDUCATION SECTOR, 10.

[3] M. A. Qadri, R. Hidayat, dan A. H. Purwadi. (2022) "Kemampuan komunikasi matematis siswa MTs berdasarkan self-confidence pada PBL berbantuan modul STEM," *Jurnal Nasional Pendidikan Matematika*, vol. 6, no. 2, pp. 234–245.

[4] Afri, L. D., & Rahmadani, R. (2020). Perbedaan Kemampuan Penalaran Dan Pemecahan Masalah Matematis Siswa Yang Diajar Dengan Pembelajaran Tps Dan Gi. *AXIOM : Jurnal Pendidikan Dan Matematika*, *9*(1), 35. https://doi.org/10.30821/axiom.v9i1.7234

[5] Khatimah, K. (2023). *Pengaruh Model Problem Based Learning Dengan Strategi Role Playing Terhadap Kemampuan Komunikasi Matematis Siswa Mts Pada Materi Aritmetika Sosial*. UIN Syarif Hidayatullah: Jakarta.

[6] Yaniawati, R. P., Indrawan, R., & Setiawan, G. (2019). *Core Model on Improving Mathematical Communication and Connection, Analysis of Students' Mathematical Disposition*. *International Journal of Instruction*, *12(4)*, 639–654. https://doi.org/https://doi.org/10.2 9333/iji.2019.12441a

[7] OECD. 2017. PISA 2015 *Result in Focus. Paris*: PISA-OECD Publishing.

[8] Yulianti, Purnama, Y.E., & Hidayat, W. (2021) Analisis Kemampuan Komunikasi Matematis Siswa Smp Kelas VII Pada Soal- Soal Persamaan Dan Pertidaksamaan Linear Satu Variabel. *JPMI: Jurnal Pembelajaran Matematika Inovatif, 4(1),* 73- 80.

[9] Batubara, N. K., & Reflina, R. (2023). Analisis Kemampuan Pemecahan Masalah Matematis Siswa Pada Pokok Bahasan Program Linier Berdasarkan Tingkat Intelligence Quotient. *AXIOM : Jurnal Pendidikan Dan Matematika*, *11*(2), 180. https://doi.org/10.30821/axiom.v11i2.12510

[10] Halima, S.N., Depriwana, R. (2020). Kemampuan Komunikasi Matematis pada Materi Segi Empat dan Segitiga: Analisis Deskriptif Berdasarkan Keaktifan Belajar di MTs Bustanul Ulum. *Juring (Journal for Research in Mathematics Learning), 3(4),* 357-366.

[11] Deswita, Ria, Yaya S. Kusumah dan Jarnawi A. Dahlan. 2018.―Peningkatan Kemampuan Komunikasi Matematis Siswa Melalui Model Pembelajaran core dengan Pendekatan Scientific‖. *Jurnal Riset Pendidikan Matematika*, *1*

[12] Mulyani, T. (2019). Pendekatan Pembelajaran STEM Untuk Menghadapi Revolusi Industry 4.0. *Universitas Negeri Semarang , 456.*

[13] Sartika, D. (2019). Pentingnya Pendidikan Berbasis STEM Dalam Kurikulum 2013. *Jurnal Ilmu Sosial dan Pendidikan , 3*, 92. Shabira, N., & Andhany, E. (2023). Pengembangan Lkpd Berbasis Etnomatematika Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa *Nadila*. *10*(1), 147–165.

[14] Handayani, S., Rachmawati, D., & Wahyono, H. (2019). *Evaluasi Pembelajaran Berbasis STEM Mata Pelajaran Ekonomi.* Malang: Literindo Berkah Karya

[15] Susanto. (2020). Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Kemampuan Berpikir Tingkat Tinggi (HOTS) Ditinjau dari Motivasi Belajar Siswa. *JMPIS , 1*, 129.

[16] Ariani, L., Sudirman, S., & Nurhayati, S. (2019). Analisis Berpikir Kreatif Pada Penerapan Problem Based Learning Berpendekatan Science, Tecnology, Engineering, and Mathematics. *Jurnal Inovasi Pendidikan Kimia , 13*, 2309.

[17] Agustin., & Zuhdi, U. (2021) Pengembangan Media Pembelajaran Interaktif Menggunakan Articulate Storyline 3 Pada Materi Sifat Dan Perubahan Wujud Benda Untuk Meningkatkan Hasil Belajar Siswa Kelas V SD. Jurnal Penelitian Pendidikan Guru Sekolah Dasar, 9(8), 1-9.

[18] Sukiman. *Pengembangan Media Pembelajaran*. Yogyakarta: PEDAGOGIKA.

[19] Suastika, I. K., & Rahmawati, A. (2019). Pengembangan Modul Pembelajaran Matematika dengan Pendekatan Kontekstual. *Jurnal Pendidikan Matematika Indonesia , 4*, 58.

[20] Mustofa, M. R. (2021). Efektivitas Model Pembelajaran Problem Based Learning Berbasis STEM Terhadap Kemampuan Berpikir Kritis Siswa. *Jurnal Tadris IPA , 1*, 375.

[21] Putri, N. A. (2022). *Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis PJBL-STEM (Science, Technology, Engineering, and Mathematics) untuk Melatihkan Kemampuan Berpikir Kreatif Peserta Didik*. Surabaya: UINSA.

[22] Shabira, N., &Andhany, E. (2023). Pengembangan LKPD BerbasisEtnomatematika untuk MeningkatkanKemampuanPemecahan Masalah Matematis Siswa. Euc-lid, 10(1), 147-165. https://dx.doi.org/10.33603/e.v10i1.8532

[23] L. Sari and D. Herman. (2021) “Komunikasi matematis siswa melalui model Problem Based Learning (PBL),” *Jurnal Pendidikan Matematika Raflesia*, vol. 9, no. 1, pp. 55–66.
[24] Kementerian Pendidikan dan Kebudayaan, Direktorat Jenderal Guru dan Tenaga Kependidkan. 2019. *Buku Pegangan Penilaian Pembelajaran Berorientasi Pada Keterampilan Berpikir Tingkat Tinggi*. Jakarta.
[25] Utami, R. A. (2020). Pengaruh Model Role Playing terhadap Kemampuan Komunikasi Matematis Siswa pada Materi Limit. *Jurnal Variabel, 3.*