Journal of Mathematics Education and Application (JMEA)
Vol. 4, No 3, October 2025, pp. 119-125 DOI: https://doi.org/10.30596/jmea.v4i3.26828

Development of KOMAT: A Problem-Based Learning Comic Media to Enhance Students' Motivation and Learning Outcomes in Mathematics

Annisa Nur Hasanah[1*], Irvan[2]
[1,2]*Universitas Muhammadiyah Sumatera Utara*
*Corresponding Author. E-mail: annisanurhasanah@umsu.ac.id

Article Info

Keywords:
KOMAT, Comic Media, Problem-Based Learning, Learning Outcomes, Student Motivation

ABSTRACT

This study aims to develop and assess the effectiveness of KOMAT (Mathematics Comic Media) integrated with a Problem-Based Learning (PBL) approach to improve students' motivation and learning outcomes in the topic of Systems of Linear Equations in Two Variables (SPLDV). The research employed the ADDIE development model consisting of analysis, design, development, implementation, and evaluation phases. The product was validated by material and media experts and tested on 28 eighth-grade students at SMP Negeri 42 Medan. Research instruments included expert validation sheets, pretest and posttest assessments, and student response questionnaires. The validation results showed that KOMAT was highly valid, with a score of 97% from material experts and 94% from media experts. Learning outcomes improved significantly, with average scores increasing from 59% (pretest) to 88% (posttest), yielding an N-Gain of 0.71 in the high category. Furthermore, student responses averaged 88%, indicating very good engagement and motivation. These findings suggest that KOMAT is a pedagogically effective and engaging media that supports conceptual understanding and learner motivation in mathematics. Future research is recommended to explore broader applications across topics and digital formats.

To cite this article:

INTRODUCTION

Mathematics is a foundational subject that supports students in developing logical, analytical, and problem-solving skills. However, observations in several junior high schools, particularly at SMP Negeri 42 Medan, reveal that students often perceive mathematics as a difficult and uninteresting subject. This perception is largely due to the dominance of teacher-centered instruction and the absence of engaging and interactive learning media. Teachers frequently rely on conventional lecture methods and textbooks without integrating visual or contextual tools, resulting in low motivation, passive learning behavior, and limited conceptual understanding especially in abstract topics like Systems of Linear Equations in Two Variables (SPLDV).

Field findings showed that students struggled to relate SPLDV concepts to real-life situations and often failed to visualize equations and graphs in a meaningful way. This need for more contextual and engaging media is in line with Irvan et al. (2020), who demonstrated that contextual-based Flash media significantly improved student understanding in mathematics classrooms. This gap between abstract content and students' comprehension suggests a strong need for visual and contextual media to bridge the learning process. Moreover, the percentage of students achieving the minimum competency criteria (KKM) for mathematics was significantly low in previous academic semesters, indicating the urgency to explore alternative instructional strategies.

One promising approach is the integration of comic-based media in mathematics instruction. Similarly, Nurhasanah, Irvan, Nasution, and Hadi (2025) found that digital comic media effectively increased students' learning interest and engagement in mathematics. Comics offer a narrative structure that combines text and illustrations to present complex ideas in a simplified and engaging manner. According to Febriyandani and Kowiyah (2021), comic media in mathematics can attract

students' attention, improve understanding, and create an enjoyable learning atmosphere. This is supported by McCloud (2020), who emphasizes that visual narrative facilitates retention and comprehension, especially when learners are confronted with cognitively demanding material.

Furthermore, when combined with an active learning model such as Problem-Based Learning (PBL), the instructional impact can be amplified. PBL encourages students to work collaboratively, solve real-life problems, and reflect on their learning process (Fitri, Yuanita, & Maimunah, 2020). Belland (2021) adds that PBL enhances learners' autonomy and critical thinking by situating knowledge in authentic and meaningful contexts. Mushlihuddin et al (2018) reported that PBL improves students' mathematical reasoning and problem-solving ability, particularly in advanced topics like vector analysis. The use of PBL in mathematics has also been shown to promote deeper conceptual understanding and long-term academic achievement (Hmelo-Silver, 2004).

Several studies have supported the positive impact of using comics integrated with PBL in mathematics classrooms. Syukri et al. (2020) reported that mathematics comics supported by digital platforms such as GeoGebra helped students better grasp algebraic and graphical representations. The visual elements and relatable storylines in the comics fostered deeper engagement and improved students' motivation and achievement.

Given the current classroom challenges and the need to modernize instructional practices, this study aims to develop KOMAT (Mathematics Comic Media) based on the PBL model to enhance student engagement and understanding of SPLDV. It is expected that the use of KOMAT can address the learning difficulties encountered in the classroom and offer a viable instructional alternative that aligns with the demands of 21st-century education.

RESEARCH METHOD

This research applied a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to develop and test the effectiveness of KOMAT (Mathematics Comic Media) integrated with Problem-Based Learning (PBL) for eighth-grade students. The study aims to produce a valid, practical, and effective learning media to enhance students' motivation and improve their learning outcomes, especially on the topic of Systems of Linear Equations in Two Variables (SPLDV).

2.1 Research Design

The research adopted a quantitative descriptive design within the development framework. The product development process followed the ADDIE model, consisting of the following stages:

1. Analysis: Needs analysis based on curriculum review, student learning difficulties, and classroom observations at SMP Negeri 42 Medan.
2. Design: Storyboarding and development of comic content aligned with SPLDV learning objectives and PBL stages (problem orientation, data gathering, problem-solving, reflection).
3. Development: Expert validation by three validators (two university lecturers in mathematics education and one school mathematics teacher) assessing material, media, language, and visual aspects.
4. Implementation: Field testing conducted with 28 students of class VIII-G using KOMAT integrated into a PBL-based lesson for one full session (3 × 45 minutes).

5. Evaluation: Assessment of product effectiveness based on learning outcomes and student motivation using pretest-posttest and questionnaire instruments.

2.2 Participants and Setting

The participants of the field test were 28 eighth-grade students (VIII-G) of SMP Negeri 42 Medan, academic year 2023/2024. The school was selected purposively based on the availability of cooperation and previous low performance in SPLDV materials.

2.3 Data Collection Instruments

a. Expert Validation Sheet: To assess the content, visual design, and instructional quality of KOMAT.
b. Learning Outcome Tests:
   1. Pretest and posttest consisting of five essay questions related to SPLDV.
   2. Designed to measure students' conceptual understanding before and after using KOMAT.
c. Student Response Questionnaire: A Likert-scale instrument to assess students' motivation, engagement, and perception of the media.
d. Lesson Observation Sheet (for implementation fidelity, optional).

2.4 Data Analysis Techniques

a. Validation Results: Quantitatively analyzed using percentage scores from the validators. A product is considered valid if the average score is ≥ 80%.
b. Learning Outcomes:
   1. Pretest and posttest results were analyzed using N-Gain formula:

$$\text{N-Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maximum score} - \text{Pretest score}}$$

   2. The interpretation of the N-Gain score was categorized as:
      - High: N-Gain ≥ 0.7
      - Medium: 0.3 ≤ N-Gain < 0.7
      - Low: N-Gain < 0.3
   3. Effectiveness is determined by whether the average N-Gain falls in the medium or high category and at least 75% of students reach the minimum mastery level (≥ 75%) on the posttest.
c. Student Motivation: Calculated using the percentage formula:

$$\text{Precentage} = \frac{\text{Total score obtained}}{\text{Maximum possible score}} \times 100\%$$

Interpreted based on criteria: ≥ 81% = Very Good, 61–80% = Good, 41–60% = Fair, ≤ 40% = Poor.

2.5 Ethical Considerations

All students participated voluntarily with prior consent from the school and were assured confidentiality and anonymity. The research adhered to institutional research ethics guidelines and was conducted solely for academic purposes.

RESULTS AND DISCUSSION

Results

Journal of Mathematics Education and Application (JMEA)
Vol. 4, No 3, October 2025, pp. 119-125 DOI: https://doi.org/10.30596/jmea.v4i3.26828

This section presents the outcomes of the KOMAT development process and its implementation in the classroom. The findings are organized according to the stages of validation, learning outcome improvements, and student responses. Each result is analyzed based on the research objectives and supported by relevant theories and previous studies. The effectiveness of KOMAT as a media integrated with Problem-Based Learning is assessed in terms of its validity, impact on learning outcomes, and its role in fostering student motivation and engagement.

3.1 Development and Validation of KOMAT

The KOMAT learning media was developed using the ADDIE model and designed to align with the SPLDV curriculum and the principles of Problem-Based Learning. In the Development phase, expert validations were conducted to ensure the content, design, and instructional quality met educational standards. The results of the validation by both content and media experts are summarized in Table 1.

Table 1. Results of Expert Validation of KOMAT Media

Aspect	Material Expert (%)	Media Expert (%)
Content relevance	97%	-
Language clarity	98%	-
Visual design	-	95%
Illustration quality	-	92%
Attractiveness	-	95%
Average	97%	94%

The table shows that both validators considered the KOMAT media very valid, with material experts giving an average score of 97% and media experts 94%. These scores indicate that the learning media meets high instructional and design standards and is suitable for classroom implementation without major revisions.

3.2 Improvement of Learning Outcomes

To evaluate the impact of KOMAT on student learning, pretest and posttest scores were analyzed. The results are presented in Table 2.

Table 2. Students' Average Pretest and Posttest Scores

Assessment Type	Average Score (%)	Category
Pretest	59%	Not Achieved
Posttest	88%	Achieved

As shown in Table 2, the average student score increased by 29 percentage points from pretest to posttest. To assess the learning gain more accurately, the normalized gain (N-Gain) was calculated:

$$\text{N-Gain} = \frac{88-59}{100-59} = \frac{29}{41} \approx 0,71$$

According to Hake (1998), an N-Gain ≥ 0.71 is classified as high, indicating a substantial improvement in students' conceptual understanding of SPLDV after using KOMAT.

This improvement reflects the effectiveness of combining visual media and problem-based learning, both of which support active engagement and knowledge construction. As stated by Mayer (2021), meaningful learning occurs when learners actively process and integrate verbal and visual

representations. By contextualizing abstract mathematical concepts within comic narratives, KOMAT helps students build mental models and internalize knowledge.

3.3 Student Motivation and Perception

Student perceptions were collected through a questionnaire measuring motivation and engagement. The results are shown in Table 3.

Table 3. Student Motivation and Response to KOMAT

Statement	Score (%)	Category
KOMAT is interesting and enjoyable	91%	Very Goog
Helps understanding SPLDV	87%	Very Goog
Language is easy to understand	89%	Very Goog
Increases enthusiasm for learning mathematics	85%	Very Goog
Would like to use KOMAT again in future lessons	88%	Very Goog
Averege	88%	Very Goog

The average score of 88% across all indicators reflects a very good category of student engagement and motivation. These findings indicate that students responded positively to the format, visuals, and contextual learning facilitated by KOMAT.

Discussion

The results of this study provide empirical support for the effectiveness of comic-based media combined with problem-based learning strategies in mathematics instruction. The significant increase in test scores (N-Gain = 0.71) confirms that the integration of visual narrative (KOMAT) with contextual problem-solving (PBL) fosters deeper learning. This finding is aligned with Belland (2021), who argues that PBL fosters critical thinking and autonomy, while narrative visuals can anchor abstract reasoning in meaningful contexts.

The visual nature of KOMAT aligns with dual coding theory, which states that learning improves when verbal and visual information are processed simultaneously (Clark & Paivio, 2020). In SPLDV, where students often struggle with graph interpretation and algebraic representation, comic visuals serve as cognitive scaffolds to ease the transition from concrete to abstract understanding.

Moreover, student motivation, which is often overlooked in mathematics instruction, plays a crucial role in academic achievement. According to Ryan and Deci (2020), intrinsic motivation is enhanced when learners feel autonomous, competent, and connected conditions that are fostered through engaging media and collaborative problem-solving. KOMAT, by presenting content through humor, dialogue, and relatable characters, creates an emotionally supportive learning environment that sustains motivation.

These findings validate the core assumption of this study: that pedagogical innovation through media and learning models is essential in transforming students' mathematical experiences. This supports prior work by Najma and Irvan (2022), who emphasized that using realistic-context media like pocket books can help bridge conceptual understanding in mathematics. It also reinforces previous studies (Syukri et al., 2020; Kurniawan & Hardini, 2020) that documented improved performance and attitudes among students exposed to comic media in STEM learning.

CONCLUSION

This study concludes that KOMAT (Mathematics Comic Media) integrated with Problem-Based Learning (PBL) is a valid and effective instructional tool for improving students' motivation and learning outcomes in mathematics, particularly in the topic of Systems of Linear Equations in Two Variables (SPLDV). The development process, which followed the ADDIE model, produced media that received high validation scores from both material and media experts. The implementation in class VIII-G at SMP Negeri 42 Medan showed a significant improvement in student achievement, with a normalized gain (N-Gain) of 0.71, categorized as high. Additionally, students demonstrated strong enthusiasm and engagement, with an average response score of 88%, categorized as very good.

These results indicate that combining visual narratives with contextual problem-solving supports student-centered learning and fosters conceptual understanding. However, future studies are encouraged to expand the use of KOMAT across different mathematical topics, school contexts, and student populations, as well as to explore its long-term impact and potential for integration with digital learning technologies.

REFERENCES

Belland, B. R. (2021). Instructional scaffolding in STEM education: Strategies and challenges. Springer. https://doi.org/10.1007/978-3-030-74069-9

Clark, J. M., & Paivio, A. (2020). Dual coding theory and education. Routledge.

Febriyandani, R., & Kowiyah, K. (2021). Pengembangan media komik dalam pembelajaran matematika materi pecahan kelas IV sekolah dasar. Jurnal Pedagogi dan Pembelajaran, 4(2), 323–331. https://doi.org/10.23887/jp2.v4i2.37447

Fitri, M., Yuanita, P., & Maimunah, M. (2020). Pengembangan perangkat pembelajaran matematika terintegrasi keterampilan abad 21 melalui penerapan model problem based learning (PBL). Jurnal Gantang, 5(1), 77–85. https://doi.org/10.31629/jg.v5i1.1609

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data. American Journal of Physics, 66(1), 64–74. https://doi.org/10.1119/1.18809

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Kurniawan, F., & Hardini, A. T. A. (2020). Meta-analisis pengaruh media komik dalam meningkatkan hasil belajar. JISIP: Jurnal Ilmu Sosial dan Pendidikan, 4(4), 492–496. https://doi.org/10.36312/jisip.v4i4.1556

Mayer, R. E. (2021). Multimedia learning (3rd ed.). Cambridge University Press.

McCloud, S. (2020). Understanding comics: The invisible art. HarperCollins.

Minanda, E. (2021). Pengembangan media pembelajaran berbasis multimedia untuk meningkatkan hasil belajar siswa pada materi persegi kelas VIII SMP. Jurnal Pendidikan Matematika dan IPA, 12(2), 114–121.

Mushlihuddin, R. (2020). Effectiveness of learning media using contextual based macromedia flash for junior school students Al Hikmah Medan. In *Journal of Physics: Conference Series* (Vol. 1429, No. 1, p. 012002). IOP Publishing.

Mushlihuddin, R., Nurafifah, & Irvan. (2018, January). The effectiveness of problem-based learning on students' problem solving ability in vector analysis course. In *Journal of Physics: Conference Series* (Vol. 948, p. 012028). IOP Publishing.

Najma, S., & Irvan, I. (2022). Pengembangan pocket book math berbasis dengan pendekatan matematika realistik dalam meningkatkan kemampuan pemahaman matematis siswa. AKSIOMA: Jurnal Matematika dan Pendidikan Matematika, 13(3), 499-511.

Nasution, H. F. (2021). Instrumen penelitian dan urgensinya dalam penelitian kuantitatif. Jurnal Ilmiah Metodologi Penelitian, 3(1), 59–75.

Nurhasanah, N., Irvan, I., Nasution, M. D., & Hadi, N. S. P. (2025). Digital math comic development based on thinking to increase students' interest in learning. Prima: Jurnal Pendidikan Matematika, 9(2), 268–291.

Purnamasari, N. L. (2020). Metode ADDIE pada pengembangan media interaktif Adobe Flash pada mata pelajaran TIK. Jurnal Pendidikan dan Pembelajaran Anak Sekolah Dasar, 5(1), 23–30.

Restika, R. (2021). Pengembangan bahan ajar siswa berbasis komik menggunakan model pembelajaran induktif pada materi aljabar. Jurnal Pendidikan Matematika, 3(2), 45–52.

Rijal, A., & Yurmianti. (2021). Pengembangan komik sebagai media pembelajaran matematika untuk siswa kelas V sekolah dasar. Caruban: Jurnal Ilmiah Ilmu Pendidikan Dasar, 4(2), 79–90.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic motivation and self-determination in human behavior. Springer. https://doi.org/10.1007/978-1-4899-2271-7

Suhendra, A. D., Asworowati, R. D., & Ismawati, T. (2020). Penerapan model problem based learning (PBL) terhadap hasil belajar matematika siswa SMPN 1 Simeulue Tengah. Akrab Juara, 5(1), 43–54.

Syukri, M., Alamsyah, Y., & Hasibuan, H. (2020). Pengembangan komik matematika berbasis problem based learning berbantuan GeoGebra untuk meningkatkan hasil belajar siswa. Akrab Juara, 5(1), 43–54.

Khairunisa, U., Azis, Z., & Sembiring, M. B. (2020). Pengembangan lembar kerja peserta didik dengan model problem based learning berbasis higher order thinking skills. MES: Journal of Mathematics Education and Science, 6(1), 56–61.

Aprilla, C. R. (2020). Pengembangan media pembelajaran matematika berbasis komik untuk meningkatkan keterampilan pemecahan masalah siswa. Thinking Skills and Creativity Journal, 3(2), 52–62.

Fauhah, H., & Brillian, R. (2021). Analisis model pembelajaran make a match terhadap hasil belajar siswa. Jurnal Pendidikan Administrasi Perkantoran, 9(2), 325–332.