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Developing problem-based learning comic to enhance mathematical literacy skills for elementary students

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ABSTRACT

The lack of mathematical literacy among primary school students, especially in understanding and interpreting data, highlights the need for contextual and visual learning media to support mathematical thinking. This study aims to develop a comic-based learning media using the Problem-Based Learning (PBL) model to enhance students' mathematical literacy on data presentation. The development process adopts the ADDIE model, including analysis, design, development, implementation, and evaluation stages. The analysis stage identifies students' needs, followed by the design stage, which involves developing storyboards and comic visualizations using Canva. The comic was validated by subject matter, media, and language experts. The subjects were III-grade students and teachers at SD Negeri 058374 Sei Limbat. Data collection instruments included validation sheets, practicality questionnaires, and mathematical literacy tests. The validation demonstrated high feasibility in terms of content, visual design, and language. Practicality was reflected in the ease of use and student engagement. Effectiveness was measured using a pretest and a posttest, with a gain score analysis. This study confirmed that PBL-based comic media is valid, practical, and effective in improving students' mathematical literacy in data presentation, supporting critical thinking and problem-solving skills in a contextual learning environment.

ABSTRAK

Rendahnya kemampuan literasi Matematika di kalangan peserta didik sekolah dasar, dalam memahami dan menafsirkan data, menunjukkan pentingnya media pembelajaran kontekstual dan visual untuk mendukung pemikiran matematis. Penelitian ini bertujuan untuk mengembangkan media pembelajaran berbasis komik menggunakan model Problem-Based Learning (PBL) guna meningkatkan literasi Matematika peserta didik dalam penyajian data. Proses pengembangan mengadopsi model ADDIE, yang meliputi tahap analisis, desain, pengembangan, implementasi, dan evaluasi. Tahap analisis mengidentifikasi kebutuhan peserta didik, diikuti dengan tahap desain yang melibatkan pengembangan storyboard dan visualisasi komik menggunakan Canva. Komik tersebut diverifikasi oleh ahli materi pelajaran, media, dan bahasa. Subjek penelitian adalah peserta didik kelas III dan guru di SD Negeri 058374 Sei Limbat. Alat pengumpulan data meliputi lembar verifikasi, kuesioner kepraktisan, dan tes literasi Matematika. Validasi menunjukkan tingkat kelayakan yang tinggi dalam konten, desain visual, dan bahasa. Praktisitas tercermin dalam kemudahan penggunaan dan keterlibatan peserta didik. Efektivitas diukur menggunakan pretest dan posttest, dengan analisis skor gain. Studi ini membuktikan bahwa media komik berbasis PBL valid, praktis, dan efektif dalam meningkatkan literasi Matematika peserta didik dalam penyajian data, serta mendukung keterampilan berpikir kritis dan pemecahan masalah dalam lingkungan belajar kontekstual.

Kata Kunci: *literasi Matematika; media komik; problem-based learning; sekolah dasar*

INTRODUCTION

Indonesian students' mathematical literacy skills continue to demonstrate low performance across various international assessments. The majority of students are not yet able to represent everyday life situations in appropriate mathematical models, indicating limited mastery of conceptual and contextual thinking (Pandiangan & Lubis, 2024). PISA 2022 data recorded that only 18% of Indonesian students reached the minimum level of mathematics literacy, far behind the OECD average of 69% (accessed at: https://www.oecd.org/en/publications/2023/09/education-at-a-glance-2023_581c9602.html). This problem is exacerbated by the low competence in higher-order thinking skills such as reasoning and problem-solving, which are central to mathematical literacy. Literature study results show that students often experience confusion in understanding information from text problems and in constructing appropriate mathematical representations (Susanti *et al*., 2022). Decreased motivation to learn Mathematics and a lack of contextual learning experience are factors that contribute to declines in this achievement (Amir *et al*., 2024). This condition underscores the urgency of designing innovative learning that integrates real-world context into the Mathematics learning process in a meaningful way.

A classroom observation in Grade III at SD Negeri 058374 Sei Limbat reinforces national findings regarding students' low mathematical literacy (Subanji, 2024). Most students are unable to identify important information in story problems, do not record their problem-solving procedures, and provide only final answers without clear mathematical reasoning. The results of their responses indicate that mathematical thinking processes have not been systematically developed, particularly in formulating and interpreting, which are rated very low (Asria & Nurhayati, 2024; Minangkabau *et al*., 2024). Mathematics learning at SD Negeri 058374 Sei Limbat, particularly in data, is hindered by various challenges that affect students' mathematical literacy. Students encounter difficulties understanding the basic concepts of data collection, processing, and presentation, as well as interpreting information presented in tables or simple graphs.

This condition indicates limited mastery in formulating, applying, and interpreting within the framework of mathematical literacy. The use of concrete media has been reported to improve students' numeracy skills, although its implementation remains limited in schools (Lisnasari *et al*., 2025). Students also often experience difficulties understanding mathematical concepts and solving problems due to internal and external factors, including limited variation in teaching methods (Amanda *et al*., 2024; Sari & Madio, 2021). Students' fear and boredom toward Mathematics can be overcome by developing teachers' more creative and engaging teaching skills (Rahmaini & Chandra, 2024). Innovation in Mathematics learning, such as the development of contextual and interactive learning media, is needed to improve students' understanding and interest in data materials.

The phenomenon of low mathematical literacy among elementary school students is consistent with previous findings that students tend to memorize procedures without understanding the meaning of each step they perform (Prayitno *et al*., 2025). Their ability to interpret results in real-life contexts remains limited, indicating that students are not yet accustomed to reflecting on the mathematical solutions they obtain (Armelia & Ismail, 2021). The lack of learning media that support visual and contextual understanding also contributes to students' limited absorption of mathematical material related to everyday life (Trisnaningtyas & Khotimah, 2022). In addition, the lack of implementation of problem-based learning models leaves students unaccustomed to independently developing problem-solving strategies (Jannah & Habiby, 2022).

This problem underscores the need to develop contextual, visual learning media. Problem-Based Learning (PBL) comic media were developed to address this challenge because they present material in an engaging visual narrative that is easy for students to understand (Nurlaeli, 2022). The PBL model supports students in building conceptual understanding by solving real-world problems, thereby encouraging

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exploration and active involvement during learning (Andani *et al.*, 2021). The combination of comic media and PBL has been shown to increase student participation, as both position students as active and reflective learners (Damayanti & Astuti, 2024). Comics designed based on the PBL approach also provide collaborative and contextual learning spaces, which have been shown to improve students' Mathematics learning outcomes (Artanegara *et al.*, 2024). Students' ability to connect text, images, and mathematical concepts also improved significantly when using creatively packaged comic media (Safitri *et al.*, 2022).

Students' interest in learning Mathematics will increase if the media used aligns with their cognitive development stage. Conventional approaches that rely on textbooks have proven less effective for students in the concrete operational stage (Rahmadani *et al.*, 2022). The PBL model, which presents real-world problems, allows students to understand concepts through direct experience, while comic media simplify these problems into easily digestible visual stories (Fitria *et al.*, 2020). The implementation of PBL-based comic media has shown a significant improvement in students' ability to formulate, apply, and interpret mathematical problems (Imami *et al.*, 2025). The use of Canva in comic development provides teachers with the flexibility to create engaging media that aligns with the characteristics of elementary school students (Sahputri *et al.*, 2024). The need for contextual and enjoyable learning media highlights the importance of integrating the PBL model and comics as an effective approach in improving students' mathematical literacy (Sipahutar, 2022).

The development of PBL-based comic media was undertaken to address low mathematical literacy among elementary school students, particularly in data presentation. The PBL model was chosen because it has the potential to encourage active student involvement during the learning process. In contrast, comic media was selected for its visual characteristics that suit the concrete thinking development stage of elementary school children. The Canva application was used to design comic media to enhance the material's visual appeal, contextual relevance, and ease of understanding. This study focused on the development of PBL-based comic learning media and on testing its validity, practicality, and effectiveness in improving the mathematical literacy skills of third-grade students at SD Negeri 058374 Sei Limbat.

LITERATURE REVIEW

Students' Mathematical Literacy Skills

Mathematical literacy skills encompass students' cognitive processes for formulating, employing, and interpreting mathematical concepts in real-life contexts. This literacy is not only about understanding concepts but also involves connecting mathematical thinking to authentic situations students encounter in their daily lives (Nurhalisza *et al.*, 2024). This understanding provides a foundation for students to transform verbal or visual problems into mathematical models using appropriate problem-solving strategies and to evaluate results in relevant contexts (Azzahroh & Putri, 2023). The connection between real-life contexts and mathematical problem-solving strategies is an important indicator of students' mathematical literacy.

Assessment of mathematical literacy skills can be seen from indicators such as the ability to formulate mathematical models, use appropriate procedures, and interpret results in real-world contexts. Recent research indicates that elementary school students in Indonesia continue to face limitations in these three aspects, particularly in formulating and interpreting, due to the still-dominant rote-based learning approach (Nasuha & Ammamiarihta, 2023). This problem is reinforced by the low levels of Indonesian students' mathematical literacy in international assessments such as PISA and national assessments such as AKM, highlighting the need for learning strategies and media that can activate both abstract and concrete thinking simultaneously (Rohim, 2021). A comprehensive understanding of mathematical literacy is an important foundation in designing learning approaches that are relevant and contextual for elementary school students.

Problem-Based Learning (PBL) Model

Problem-Based Learning (PBL) is a learning model that places students at the center of the learning process, where they learn by solving real problems collaboratively and reflectively. This model encourages students to apply Mathematical concepts and procedures in authentic contexts, thereby strengthening their mathematical literacy. The PBL syntax includes problem introduction, student organization, independent or group investigation, development and presentation of solutions, and reflection on the learning process (Akras & Pujiastuti, 2025). The PBL model has been proven to significantly improve students' mathematical literacy skills across various educational levels. The use of this model positively impacts the development of critical thinking skills, problem-solving, and active student engagement in Mathematics learning (Firdaus et al., 2021).

Recent meta-analyses indicate that PBL has a substantial effect on improving mathematical literacy, with effect sizes up to 2.99 (Praneswari et al., 2025). The implementation of PBL at the elementary school level also shows promising results, particularly in numeracy and pattern materials, with learning outcomes improving significantly following instruction (Listyaningsih et al., 2023). Contextualizing problems through the PBL approach has been shown to enhance learning motivation, student engagement, and reflective thinking skills (Achyani et al., 2024). The integration of PBL with visual learning media, such as number boards and other manipulatives, measurably strengthens students' numeracy literacy (Kardoyo et al., 2020; Ningtias et al., 2024; Nurchurifiani & Zulianti, 2021). Based on these findings, PBL can be described as a learning approach that is relevant and significantly strengthens mathematical literacy by enhancing conceptual understanding, higher-order thinking skills, and active student engagement in the contextual learning process.

Development of Comic Media

The development of comic media as a means of learning Mathematics in elementary schools is driven by the need to provide media that can simplify abstract concepts into concrete, engaging, and easily understood visual representations for students. Comics, as a narrative-based visual medium, have been shown to enhance students' understanding of concepts and motivation to learn Mathematics (Maulidia & Lestari, 2024). Research shows that comic media developed through the ADDIE model is feasible for learning, with content validity and visual design rated very good (Artanegara et al., 2024). In addition, comics have the potential to build mathematical literacy by strengthening the connections among text, images, and problem contexts (Suari et al., 2024). The integration of comic media into mathematics learning can be a strategic means of stimulating students' mathematical thinking processes in a visual, contextual, and meaningful way.

Visualizing stories in the form of comics provides students with an opportunity to experience a more enjoyable and communicative learning process, while simultaneously stimulating cognitive and affective development in a balanced way. Mathematics comics that adopt a realistic approach help students connect the material to everyday experiences, thereby supporting the development of critical and reflective thinking skills (Melati et al., 2023). Studies also show that the use of comics can reduce students' anxiety toward Mathematics and enhance learning outcomes through structured visual stimulation (Rahayu et al., 2022). Using platforms such as Canva enables teachers to design educational comics that are visually appealing and readily adaptable to students' characteristics (Nurlina et al., 2024). Therefore, the development of comic media is a pedagogical innovation relevant to 21st-century Mathematics learning (Amalia et al., 2024).

METHODS

This study is a research and development (R&D) project that uses the ADDIE model to develop Problem-Based Learning (PBL) comic media for data presentation. The research activities were carried out at SD Negeri 058374 Sei Limbat, Selesai District, Langkat Regency, North Sumatra Province, in the even semester of the 2023/2024 academic year. The subjects of this study were material experts, media experts, language experts, third-grade teachers, and third-grade students at SD Negeri 058374 Sei Limbat. At the same time, the object of the research was the Problem-Based Learning-based comic media developed to improve students' mathematical literacy skills.

This research uses the ADDIE development model (analysis, design, development, implementation, evaluation) with the following stages:

1. *Analysis*

   The analysis stage begins with a review of the curriculum in effect at the elementary school level to identify basic competencies relevant to data presentation materials. In addition, the characteristics of third-grade students at SD Negeri 058374 Sei Limbat are analyzed through an examination of their cognitive, social, and learning preferences, which develop at that age. This process continues with the implementation of classroom observations and documentation studies to identify concrete problems faced by students and teachers in understanding and teaching data presentation material. The problems identified include low conceptual understanding, limited student interest in learning, and limited use of contextual learning media in the classroom. Based on these findings, the need for problem-based learning media that align with the actual classroom conditions is systematically mapped. The activities at this stage serve as a foundation for designing comic media that can facilitate visual, engaging, and contextual learning of Mathematics in accordance with the PBL approach.

2. *Design*

   The design stage begins with the formulation of learning indicators that address the basic competencies of data presentation, and the development of the comic storyline, organized according to the PBL framework, including the stages of problem orientation, data collection, analysis, solution development, and reflection. The comic narrative is designed to depict real-world problem contexts that are close to the students' experiences, thereby facilitating a more meaningful understanding of the concepts. The design process continues with the preparation of storyboards and visual layouts, including the placement of text, illustrations, and image flow, using the Canva application, to produce comics that are communicative, aesthetically pleasing, and suitable for elementary school students. In addition to media design, this stage also includes the development of research instruments consisting of validation sheets to assess the feasibility of content, visual appearance, and language by experts; practicality questionnaires for teachers and students measuring aspects of ease of use, media attractiveness, and content suitability based on the formulate, employ, and interpret indicators to assess the effectiveness of the media in developing students' mathematical thinking skills.

3. *Development*

   The development phase involved translating the initial design into a digital comic media prototype created in Canva. The comic contains visual narratives that integrate PBL syntax and is developed in accordance with the storyboard and learning indicators prepared in the previous stage. The initial prototype was then validated by three experts: a content expert, a media expert, and a language expert, using a prepared validation sheet instrument. The validation process aimed to evaluate the content's feasibility systematically, the visual presentation's quality, and the media's language aspects. The validation data were analyzed using quantitative descriptive techniques, in which assessment scores for each aspect were converted into percentages and categorized into predefined classes to determine the product's feasibility level. This analysis provides an objective basis for revising and refining the media before proceeding to the implementation stage.

4. *Implementation*

The implementation stage was conducted through a limited trial involving classroom teachers and third-grade students at SD Negeri 058374 Sei Limbat, who served as early users of the developed comic media. This trial aimed to obtain direct feedback on the practicality of using media in data presentation learning based on PBL, as students followed the activity flow presented in the comic both independently and in groups. Practicality data were collected using a questionnaire designed to assess indicators of ease of use, visual appeal, and suitability for learning objectives. Furthermore, the data were analyzed quantitatively and descriptively, and categorized using interpretive criteria for practicality levels to determine the extent to which the media can be effectively applied in the classroom. This analysis serves as a basis for considering improvements and refinements to the media before testing its effectiveness in the next stage.

5. *Evaluation*

The evaluation stage was conducted to assess the effectiveness of PBL-based comic media in improving students' mathematical literacy. This evaluation was conducted by administering mathematical literacy tests before (pre-test) and after (post-test) the use of the media in the learning process. The test instruments were developed based on mathematical literacy indicators, which include formulating, employing, and interpreting. The pre-test and post-test data were then analyzed to calculate the gain score as an indicator of students' skill improvement. Furthermore, a t-test was conducted using statistical software to quantify the significance of score differences. The evaluation process aims to provide empirical evidence on the quality of the developed media in terms of validity, practicality, and overall effectiveness, thereby serving as an alternative approach to meaningful, contextual Mathematics learning for elementary school students.

RESULTS AND DISCUSSION

Analysis Stage

The analysis stage was conducted to identify the mathematics learning needs in elementary school, particularly regarding the data material taught in grade III. Information was collected through observation of the learning process, study of curriculum documents, and interviews with class teachers. The results of the observations indicated that mathematics instruction continues to rely on lecture methods and exercises, with textbooks as the primary resource. Teachers have not used visual media to support understanding of data concepts in a contextual and meaningful way. The material is delivered without being linked to real-life situations that are close to students' experiences, leading students to be passive and to have difficulty understanding the meaning and usefulness of data presentation, as shown in **Table 1**.

Table 1. Results of Mathematical Literacy Ability Analysis

Cognitive Process	Achievement Indicator	Analysis Results of Student Responses
(*Formulate*)	Formulating information from the presented text into mathematical language.	72% of students can determine house numbers from the information provided, but do not formulate a clear, logical process. The remaining 28% answered incorrectly.
(*Employ*)	Applying addition and subtraction operations to solve problems.	12% of students answered correctly. 80% of students arranged the house numbers from the smallest to the largest. 8% of students answered incorrectly. However, none of the students wrote down the steps of the solution.

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Cognitive Process	Achievement Indicator	Analysis Results of Student Responses
(*Interprete*)	Interpreting mathematical results back into a real-world context	All students were unable to answer the questions correctly.

Source: 2025 Research

Interviews with teachers indicate that most students are not yet able to read and interpret data presented in tables or bar charts. Students have difficulty answering story problems that contain data elements because they are not accustomed to modeling situations mathematically. Teachers also stated that students grasp concepts more quickly when accompanied by images or stories relevant to their daily contexts. In addition, teachers mentioned that they have never used comic media in teaching Mathematics. Based on these findings, it can be concluded that there is a need for visual and contextual learning media to enhance motivation, engagement, and students' understanding of data. PBL-based comic media is considered relevant to develop because it can integrate real-world problems into engaging visual narratives, in accordance with the learning characteristics of elementary school students.

Design Stage

The design stage is carried out to plan the structure, content, and initial appearance of the PBL-based comic learning media to be developed. The results inform media design by identifying the needs and characteristics of third-grade students. The preparation of comic content aligns with the Basic Competencies (KD) of the third-grade Mathematics subject according to the 2013 Curriculum, particularly in data presentation. The determination of learning objectives, the sequence of material, and the PBL syntax model integrated into the comic narrative are structured to support learning through the problem-solving stages.

The comic storyline is designed in five parts according to the PBL syntax, namely: 1) presenting problems in the context of daily life; 2) identifying information and asking questions; 3) exploring and analyzing data; 4) developing solutions and representing data; and 5) reflecting on the process and results. The selection of characters, story settings, and illustrations is adapted to students' sociocultural environment to make learning more relatable and meaningful. Each page of the comic includes character dialogue, illustrative images, and contextual questions that guide students through a step-by-step problem-solving process. The Canva platform is used to design layouts, illustrations, and color palettes, making the media more visually appealing.

The comic is designed in a digital format that can be printed, making it suitable for use both in direct classroom instruction and as a self-directed worksheet. The initial design preparation is also accompanied by a research instrument plan comprising validation sheets, practicality questionnaires, and mathematical literacy test items used to assess the effectiveness of the media. The visualization of this stage is shown in **Figure 1**, which presents a storyboard of the PBL-based comic media, with storylines and illustrations arranged according to the problem-based learning syntax. This storyboard serves as the initial framework for constructing the narrative structure, dialogues, and the visual presentation of mathematical contexts. This design stage serves as the foundation for developing the comic prototype, which will be validated and tested in the next stage.
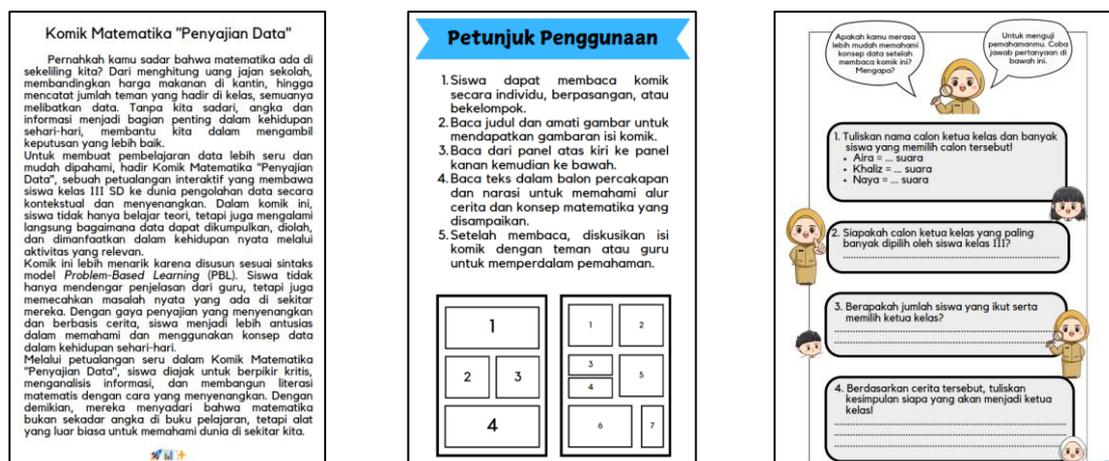
Figure 1. Comic media storyboard based on PBL
Source: 2025 Research

Development Stage

The development stage follows the completion of the initial design of the comic media. The main activity at this stage is the creation of PBL-based comic media prototypes and their validation by material and media experts. Validation is conducted to ensure that the developed media align with the learning objectives, students' characteristics, and principles of effective media development. Validation by material experts encompasses content suitability with the curriculum, accuracy of Mathematical concepts, integration with PBL syntax, and the depth and breadth of the material. The ratings are outlined in **Table 2**, which shows that the media received an average score in the category "very valid".

Table 2. Results of Expert Validation on Comic Media

No	Aspect	Assessment
I	**Format**	
1	Consistent in organizing the presentation systematically	4
2	The presentation is organized logically	4
3	Presented in order	4
4	The suitability and accuracy of the illustrations with the material	3
II	**Language**	
5	The accuracy of the grammar and spelling used	3
6	Language appropriate to the thinking level of third-grade elementary school students and their mathematical literacy skills	4
7	The language used is communicative	4
8	Clarity of instructions and problem-solving	4
III	**Content**	
9	Alignment of material with Learning Outcomes	3
10	Alignment with learning objectives	4
11	The sequence of data material is clear	3
12	In-depth study of data concepts and material	3
13	The content guides students to improve their mathematical literacy skills	3

No	Aspect	Assessment
14	In accordance with the developing knowledge	3
	Feasibility Percentage	**85.71%**

Source: 2025 Research

Validation by media experts includes visual appearance, text readability, design consistency, and the suitability of colors, images, and layout. The results of media expert validation are shown in Table 3, which indicates that the media were assessed as feasible and attractive, with a rating of "very valid".

Table 3. Media Expert Validation Results

No	Aspek	Penilaian
I	**Format**	
1	Room/layout settings	3
2	Font type and size are consistent	4
3	Consistency between text and illustrations	4
4	The suitability of the physical comic media and the students	3
5	Has an appeal	4
II	**Language**	
6	Grammar truth	4
7	The suitability of the language and the thinking level of Grade III elementary school students	3
8	Encouraging reading interest and appealing	4
9	The language used is communicative	4
10	Clarity of instructions and problem-solving	3
III	**Illustration**	
11	Have a clear view to clarify the concept of data	4
12	Direct relevance to the concept of data material	4
13	Can provide stimulation visually	3
14	Display clarity	4
15	Ease of understanding	4
IV	**Content**	
16	Suitability of the data material with the learning objectives	3
17	The sequence of material is clear	4
18	Clarity of data material distribution	4
19	Motivating students to learn	3
20	Fostering systematic thinking in students	4
21	Using examples that are appropriate to the local situation	4
22	Avoiding stereotypes	4
	Feasibility Percentage	**92.05%**

Source: 2025 Research

In addition to validation by content and media experts, the developed comic media was validated by language experts. This validation was conducted to assess linguistic aspects, including the accuracy of spelling and punctuation, the appropriateness of sentence structure for the developmental level of elementary school students, and the clarity of meaning in the comic dialogue. The results of the validation by language experts are presented in **Table 4**, which indicates that the media's linguistic aspects fall into the 'very valid' category.

Table 4. Results of Language Expert Validation

No	Aspek	Penilaian
I	**Language Rules**	
1	The grammar used conforms to the rules of the Indonesian language	4
2	Correct and consistent spelling	4
3	Punctuation follows the rules	4
II	**Readability**	
4	The words used are easy to understand and contextually appropriate	4
5	The sentence structure is clear and understandable	3
6	Each sentence is interconnected and cohesive	3
7	The language used is in accordance with the background of the knowledge of grade III elementary school students	4
III	**Language Consistency**	
8	Consistent writing style	4
9	The language used is adjusted to the target readers, namely, third-grade elementary school students.	4
IV	**Suitability with Context**	
10	The dialogue between characters in the comic supports students' understanding of the material on data.	3
11	Word choice can bring characters and the story's atmosphere to life.	3
	Feasibility Percentage	**93.18%**

Source: 2025 Research

Implementation Stage

The implementation stage follows the validation and revision process in the development stage. The main activity at this stage is a limited trial to assess the practicality of using the media and to evaluate its effectiveness in improving elementary school students' mathematical literacy skills. The implementation was conducted with third-grade students at SD Negeri 058374 Sei Limbat, comprising 25 participants. The trial was conducted across two learning sessions using the PBL-based comic that had been developed.

During the implementation process, the teacher used comics as the main medium to convey material on data presentation. The learning followed the PBL framework, integrated into the comic story flow, beginning with presenting the problem, exploring information, solving problems, and reflecting. The teacher served as a facilitator, while the students actively read, discussed the comics' content, and solved contextual problems embedded in the story. Observations showed that the students appeared enthusiastic

and actively engaged in the learning process. The comics successfully captured their attention and facilitated understanding of the concept of presenting data in tables and charts.

After learning, students and teachers were asked to complete a practical questionnaire to assess the ease of use of the media, readability, content clarity, and interest in comics. The results of the questionnaire analysis showed that the media was in the "very practical" category, with an average assessment score exceeding 85%. The teacher stated that comic media helped explain the material more concretely. At the same time, students reported that it was easier to understand because it was conveyed through engaging illustrated stories and aligned with their experiences. Based on the results of this limited trial, it can be concluded that PBL-based comic media is suitable for use in Mathematics learning and meets the criteria of practicality.

Evaluation Stage

The evaluation stage was conducted to assess the effectiveness of PBL-based comic media in improving elementary school students' mathematical literacy. This evaluation was conducted by administering a mathematical literacy test comprising context-based questions on data presentation materials. The test was given before and after learning (pretest and posttest) to 25 third-grade students of SD Negeri 058374 Sei Limbat as participants in a limited trial. The questions were adjusted to align with indicators of mathematical literacy, including the ability to formulate problems, apply mathematical concepts, and interpret results in real-life contexts.

The data analysis indicates an increase in average scores from the pretest to the posttest. The students' average pretest score before using the media was in the low range, with a mean of 56.4. After using comic media for learning, the average posttest score increased to 82.7, placing in the high category. To quantify the level of improvement, a gain score was calculated using Hake's formula. The calculation results showed a gain of 0.61, which falls within the medium-to-high category. Additionally, a t-test was used to compare pretest and posttest scores; the result was $p < 0.05$, indicating a significant difference in learning outcomes before and after using the media.

These findings indicate that PBL-based comic media are effective in enhancing students' mathematical literacy skills, particularly in helping them understand and interpret data presented in tables and diagrams. The media not only facilitates conceptual understanding but also shapes students' thinking patterns in solving contextual problems in a structured manner according to PBL syntax. Thus, the developed media meet the criteria for effectiveness and are suitable as alternative learning media for Mathematics in elementary schools.

Discussion

The development of comic learning media in the context of Mathematics is based on the need to visualize abstract concepts more concretely and attractively for elementary school students (Afifah & Dewi, 2022). Research results indicate that PBL-based comic media are highly valid, practical, and effective in enhancing the mathematical literacy skills of elementary school students. This aligns with other studies indicating that e-comics designed using the ADDIE model have proven feasible and effective in conveying mathematical content, such as fractions and geometry, with media and material validity exceeding 90%, and student and teacher responses indicating a very good category (Febriyandani & Kowiyah, 2021). Validation by media and materials experts indicates that the comic is highly suitable for use, effectively facilitates mathematical problem-solving, and can build an emotional connection that encourages active student engagement (Astuti *et al*., 2021).

The process of evaluating effectiveness through gain score analysis also indicates improvements in students' mathematical literacy, particularly in formulating, using, and interpreting data in the context of data presentation (Amalia *et al.*, 2024). This feasibility and effectiveness are further strengthened by a multimodal approach to developing comic media, in which text and images blend to form a more complete representation of mathematical meaning, such as graphs or bar diagrams (Bina *et al.*, 2024; Yulaichah *et al.*, 2024). The use of e-comics, employing a realistic approach that connects mathematical concepts to real-life situations and local culture, has significantly enhanced students' critical and creative thinking skills (Febriyandani & Kowiyah, 2021). In addition, the visual design of comics that combine text and visual narratives has been shown to reduce students' anxiety toward Mathematics, increase learning motivation by 72%, and improve conceptual understanding by up to 68% (Rahmi *et al.*, 2024).

The positive influence of comic media on students' mathematical thinking is also supported by prior research indicating that visual narratives in comics help simplify abstract concepts and strengthen students' cognitive connections to mathematical representations (Jannah & Habiby, 2022). In addition, the use of interactive media facilitates learning and enhances its effectiveness (Rahmawati *et al.*, 2024; Rosyiddin *et al.*, 2023). The PBL syntax integrated into the comic story provides a learning experience that is collaborative, exploratory, and reflective, thereby directly supporting the development of mathematical literacy among lower-grade students (Nurchurifiani & Zulianti, 2021). This also indicates that the use of comic-based instruction in basic mathematics significantly enhances students' visual representations, procedural understanding, and problem-solving, particularly in the early grades (Belda-Medina, 2024).

The development of PBL-based comic media is designed to strengthen mathematical literacy among third-grade elementary school students at the concrete operational stage of development. Students at this level tend to find it easier to understand concepts through visualization and contextual narratives that are close to everyday experiences. Comics, as a visual story-based medium, provide concrete and meaningful mathematical representations, making it easier for students to formulate problems, employ solution procedures, and interpret results in real-world contexts. Research indicates that integrating comic media into mathematics learning facilitates the connection between symbolic and visual understanding, which is important for developing mathematical literacy among students aged 8-9 years (Kolar & Hodnik, 2021; Ully & Hakim, 2022). The selection of the PBL model also enhances the effectiveness of the media by encouraging students to think critically, develop problem-solving strategies, and actively reflect on the learning process (Lestari *et al.*, 2021; Ningtias *et al.*, 2024). Therefore, the development of PBL-based comics is a relevant pedagogical approach for systematically and contextually facilitating mathematical literacy among third-grade elementary school students.

The contribution of this medium becomes increasingly important for third-grade elementary school students in the concrete operational stage, when the need for visual media is high to support contextual and applicational understanding of mathematical concepts. Comic designs that contain stories close to the daily lives of students have been proven not only to build interest and motivation but also to support their ability to understand, use, and interpret data presented in the form of simple tables and graphs (Damayanti & Astuti, 2024; Febriyandani & Kowiyah, 2021). Therefore, the development of PBL-based comic media has empirically demonstrated its effectiveness as an alternative learning strategy for addressing low mathematical literacy among elementary school students, particularly in data presentation.

CONCLUSION

This study developed a PBL-based comic media that is valid, practical, and effective in improving the mathematical literacy skills of third-grade students at SD Negeri 058374 Sei Limbat in data presentation. Validation by experts in materials, media, and language demonstrated that this medium meets the criteria for high feasibility. The practicality of the media is reflected in teachers' and students' responses, which

indicate that the comic is easy to use, engaging, and appropriate for the learning context. The effectiveness of the media is evident in improvements in students' mathematical literacy in formulating, employing, and interpreting, as assessed using gain scores and t-tests. These results indicate that the comic media can make a positive contribution to contextual, reflective, and meaningful Mathematics learning. Further research is recommended to develop similar comic media for different grade levels and other Mathematics materials, and to integrate them into an interactive digital format to enhance adaptability to technology-based learning. Additional evaluation could also involve large-scale trials to examine the consistency of the media's effectiveness across various elementary school contexts.

AUTHOR'S NOTE

The author states that there is no conflict of interest related to the publication of this article. The author emphasizes that the article's data and content are free of plagiarism.

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