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Development of E-colands (Electronic Comic of Peatlands) for Junior High School Mathematics Learning

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ABSTRACT

Low mathematical literacy among Indonesian students, as indicates by PISA results, highlights the need for innovative and contextual learning media that connect mathematics with real-life situations. This study aimed to develop and examine the feasility and praticality of E-Colands (Electronic Comic of Peatlands) as a mathematics learning medium for junior high school students in Central Kalimantan. The research employed a research and development method using the ADDIE model, limited to the Analysis, Design, Development, and Implementation stages. E-Colands was designed as a digital comic integrating matematical literacy tasks with peatland contexts encountered in students' daily lives. Product feasibility was assesed through expert judgment by material and media experts using Likert-scale validition instruments. Practicality was evaluated through student response questionnaires administered to 75 students from grades VII, VIII, IX selected through purposive sampling. The results showed very high level feasibility, with validation scores of 91.25% form material experts and 89.29% from media experts. Students responses indicated good practicality, with an overall score of 80.49%, expecially in language clarity, media design, and ease of use. These findings suggest that E-Colands is a valid and practical learning medium to support contextual mathematics learning and enhance students' mathematical literacy.

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1. INTRODUCTION

Mathematical literacy is an element assessed in the Program for International Student Assessment (PISA), a study conducted by the Organization for Economic Cooperation and Development (OECD) that assesses the education systems of its member countries (Stacey & Turner, 2014). Mathematical literacy is one of the abilities that can help students apply mathematics in real life, for example to solve problems and analyze conclusions (Kolar & Hodnik, 2021). The results of the ranking of mathematical

literacy skills in Indonesia based on PISA and TIMMS in 2022 were ranked 64th out of 65 countries, showing no significant improvement (Teig et al., 2022). This indicates that students in Indonesia are included in the group with very low literacy skills (Setiawi et al., 2025). The following are several factors that cause low mathematical literacy skills: (1) lack of interest in reading among students; (2) learning provided by educators is too monotonous; and (3) a less conducive classroom and family environment (Hwang & Ham, 2021). The solution to address this is the need to develop learning media that can increase students' interest in reading, so that students do not feel bored during the learning process (Umairoh & Amaliyah, 2022). Based on these problems, students need literacy media that can increase reading interest and have attractive visuals for them.

The current condition of mathematical literacy in Indonesia in 2022 ranked 64th out of 65 participating countries, indicating that students' mathematical literacy skills in Indonesia remain very low (Muktamaroh et al., 2023). This ranking reflects students' limited ability to formulate, apply, and interpret mathematics in various real-life contexts. Such a condition is concerning, as mathematical literacy is an essential competency that enables students to use mathematical knowledge to solve everyday problems, make decisions, and think critically in modern society. These assessment results are consistent with findings from international studies such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA), which consistently show that Indonesia's mathematical literacy has not experienced a significant improvement over recent assessment cycles (Valio et al., 2025). In many cases, Indonesian students demonstrate difficulties in understanding contextual problems, interpreting data, and applying mathematical reasoning to unfamiliar situations. This indicates that mathematics learning in schools still tends to emphasize procedural skills rather than meaningful understanding and real-world application. Several factors contribute to the low level of mathematical literacy among students. First, students' lack of interest in reading limits their ability to comprehend problem situations and mathematical texts. Second, instructional practices implemented by teachers are often monotonous and teacher-centered, which reduces student engagement and active participation in learning (Genc & Erbas, 2020). Third, classroom and family environments that are less supportive of learning further hinder the development of students' literacy skills. These conditions collectively reduce students' motivation and opportunities to develop mathematical reasoning. To address these challenges, it is necessary to develop learning media that can enhance students' interest in reading and actively engage them in the learning process, so that they do not feel bored during mathematics instruction (Sudarsana et al., 2020). Innovative and contextual learning media are expected to create meaningful learning experiences by connecting mathematical concepts to students' daily lives. Therefore, selecting and developing appropriate learning media is essential to support the improvement of students' mathematical literacy skills and to foster more effective and engaging mathematics learning in Indonesian schools..

One of the visual media for learning that can increase students' interest in reading is comics. Comics are media with images and writing in the form of stories that can invite readers to enter the storyline, so that the reader can be entertained and gain a special experience from the story (Thompson, 2023). Comics can be in print or digital form. Digital comics or can be said to be e-comics are media that can be accessed using the internet, so that students can read comics anywhere and anytime without feeling the difficulty of carrying printed comics (Hastings, 2025). The advantages of E-comics, namely: (1) motivating students in learning because of the attractive appearance and content; (2) the material presented is shorter and easier to understand; (3) can be accessed by students anywhere and anytime (Jannah & Putra, 2024). However, students must have an internet network to be able to access e-comics (Wijayanti et al., 2024). In the current digitalization era, internet networks are not difficult for students in urban areas. Therefore, researchers developed digital comics as a learning medium that can help

overcome problems experienced by students, especially in the availability of e-comics in learning. This is supported by Kustantina et al. (2022) and Mamolo (2019b, 2022) who stated that e-comics can increase student motivation and interest in learning, help students understand mathematical concepts well, reduce anxiety towards mathematics, improve critical thinking skills. However, the e-comics developed must not only have attractive visuals but also have a storyline that is in line with students' real lives so that it can help students easily understand the material presented in the comic.

The development of e-comics with storylines based on students' life experiences will greatly help improve students' problem-solving skills and mathematical literacy skills (Putri et al., 2025). One real-world context that can be linked to learning is the peatland context, this is because Central Kalimantan has extensive peatlands and its residents are quite familiar with peatlands (Sakuntaladewi et al., 2024). Peatlands are land formed from vegetation found on them with low topography and high rainfall (Li et al., 2024). Peatlands in Central Kalimantan cover an area of 2.65 million hectares, which is 16.83% of the total area of the province (Nasir, 2023). Although much research has been conducted on the use of comics in mathematics learning, most studies only focus on increasing motivation or conceptual understanding without integrating local contexts related to students' lives (Fitriani & Leton, 2024). On the other hand, studies on ethnomathematics show that local contexts such as peatland ecosystems can strengthen mathematical literacy (Chananil et al., 2025), but currently there are not many who have developed digital learning media that specifically combine comic media with the context of peatlands. Therefore, peatlands are the context that researchers chose to be the background of the problem in the development of e-comics to improve the literacy skills of students in Palangka Raya, Central Kalimantan, called e-colands (electronic comic of peatlands). The background story in the comic will connect problems that often occur in the peatland environment and these problems can be solved with mathematical concepts. This is one solution that can be done by the research team to address the problem of low mathematical literacy of Indonesian students, especially in Central Kalimantan. Based on this explanation, researchers developed a digital comic with the context of peatland problems for students in Central Kalimantan.

2. METHODS

The research uses a development method with the ADDIE model (1950) which is an important solution in improving the quality of learning according to needs. The ADDIE model has five stages, namely; (1) Analysis; (2) Design; (3) Development; (4) Implementation; (5) Evaluation. However, in this study, the researcher only limited the research to the implementation stage. This is in accordance with Richey & Klein (2007) who stated that each stage in a development research model can be published if it has clear empirical data. The learning media developed is e-colands (electronic comic of peatlands) as a media that can help students' interest in reading and help them understand real problems that can be solved using mathematics. The ADDIE research chart can be seen in the following figure (Branch, 2009).

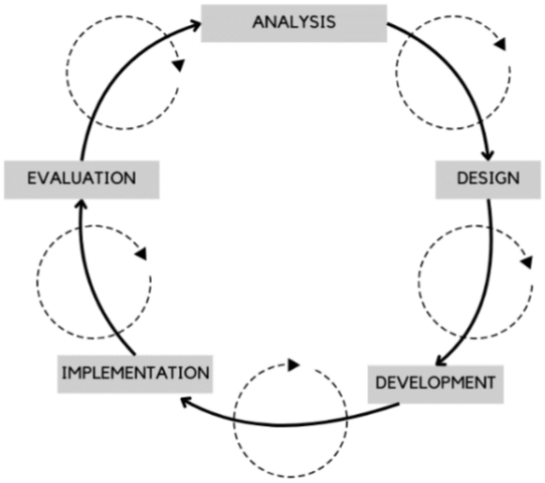


Figure 1. ADDIE's Model Stage

Based on the chart, the researcher will carry out the ADDI-E stages. This is supported by Rusdi (2018), where the ADDIE research process can be carried out with the stages A-D-D-I-E, AD-DI-E, ADD-IE, and ADDI-E. In this study, the evaluation stage will be continued by the researcher in future research which will see the improvement in students' literacy skills after implementing e-coland on a large scale to all students in the city of Palangka Raya. Therefore, an explanation of the four stages used in the researcher's study is presented in the following table.

Table 1. ADDI's Stages Explanation

No	Stages	Explanation
1.	Analysis	Analyzing student needs, student characteristics, the availability of supporting facilities, learning objectives, the tasks that students will do.
2.	Design	Determining the structure of the material, the specifications of the media to be developed, creating a storyboard for learning media, preparing expert assessment instruments and student response instruments.
3.	Development	Integrating manual comics into digital comics using flipbooks and get the validations of the materials and media.
4.	Implementation	Testing e-comics on a limited basis and get the students' responds of e-coland

Based on these development stages, the first to third stages will produce a product in the form of e-colands (electronic comic of peatlands) learning media. The validity of the product will be assessed using a validation sheet instrument by media experts and material experts. The media expert validation instrument used consists of an assessment sheet in the form of a Likert scale of 1-4 that assesses the graphic feasibility and presentation aspects, while the material expert validation assesses the content feasibility, language feasibility, and suitability aspects with mathematical connection abilities. The validation sheet is calculated using the formula:

$$V = \frac{\sum s}{n(c-1)}$$

The eligibility criteria refer to the formula Aiken (1985) with categories $V < 0.4$ weak, $0.4 \leq V \leq 0.8$ moderate, $V > 0.8$ high

The fourth to fifth stages will produce practical products based on small-scale trials and field trials, which will be assessed by students using a student response questionnaire. The questionnaire responses are calculated using the category formula presented in the following table:

Table 2. Category Formula for Measuring Educator and Student Response Questionnaires

Formula	Results	Categories
$\bar{X} > \bar{X}_i + 1.8\ x\ sb_i$	X > 4.2	Very Good
$\bar{X}_i + 0.6\ x\ sb_i < X \leq \bar{X}_i + 1.8\ x\ sb_i$	3.4 < X ≤ 4.2	Good
$\bar{X}_i - 0.6\ x\ sb_i < X \leq \bar{X}_i + 0.6\ x\ sb_i$	2.6 < X ≤ 3.4	Fair
$\bar{X}_i - 1.8\ x\ sb_i < X \leq \bar{X}_i - 0.6\ x\ sb_i$	1.8 < X ≤ 2.6	Poor
$\bar{X} \leq \bar{X}_i - 1.8\ x\ sb_i$	X ≤ 1.8	Very Poor

The eligibility percentage is calculated using the formula:

$$Percentage = \frac{Score\ obtained}{Maximum\ score} \times 100\%$$

The eligibility criteria refer to Widoyoko (2009) with categories of 85-100% very feasible, 70-84% feasible, 55-69% quite feasible, and 0-54% not feasible.

The research subjects will be conducted at SMP Negeri 2 Palangka Raya with a total of 75 students, the sampling technique used in selecting these students is purposive sampling because the researcher deliberately chose three different grade levels, namely grades VII, VIII, and IX to see variations in mathematical literacy at each level of students. The researcher has conducted initial observations at the target school. The results of the observation, namely the school really needs e-colands to support the literacy program carried out by the school every Wednesday morning. The school is also digitizing the library, therefore e-colands can be an additional literacy material in the e-library that is being worked on by the school. The field trial process will see the students' responses to e-colands and students will be assessed for their literacy skills after using comics. The research procedure that the researcher carried out was based on the ADDIE development stages as follows. Based on the research procedure in Figure 3.2, the expected results are a product in the form of e-colands in mathematics learning to improve student literacy where the context available in the comic is the context of peatlands.

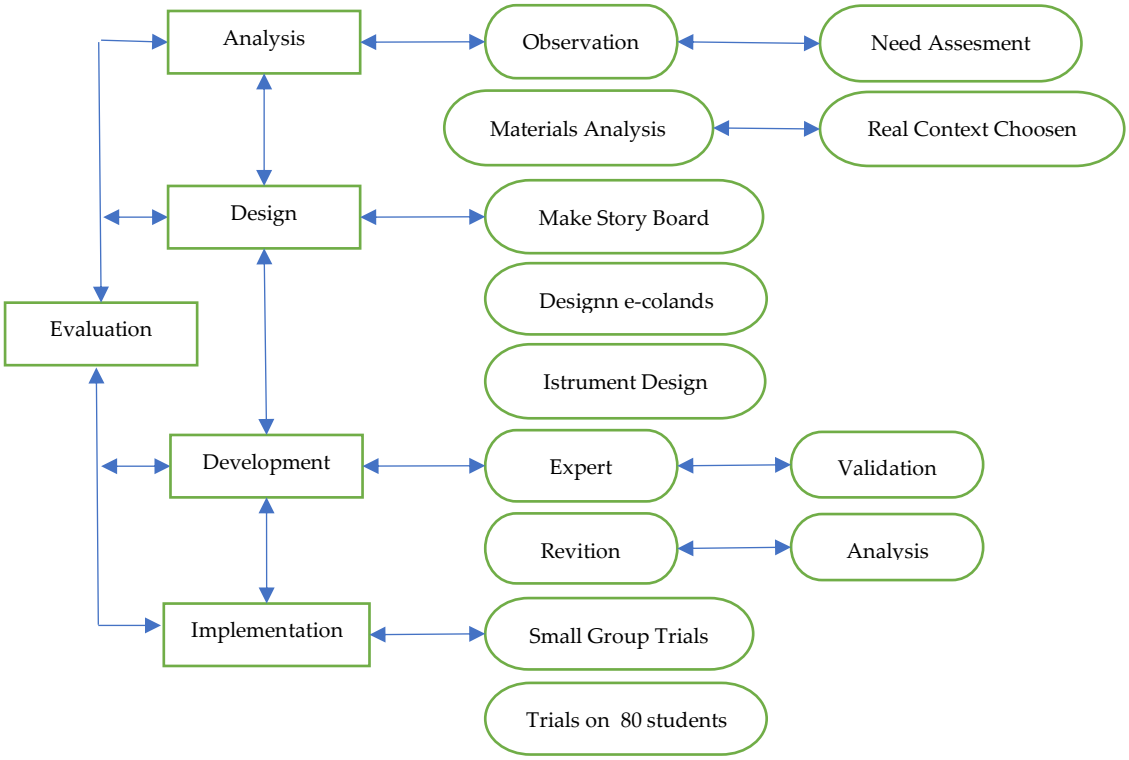


Figure 2. Research Procedure.

3. FINDINGS AND DISCUSSION

1) Analysis

The analysis phase was carried out by analyzing the research subjects' needs in terms of curriculum, materials, and media requirements. Data collection was conducted by interviewing two mathematics teachers, one curriculum vice principal, and two students at a junior high school in Palangka Raya (Rizal et al., 2021). The interviews revealed that the school had a one-hour literacy class once a week on Wednesdays. However, the literacy provided was not specifically focused on Central Kalimantan literacy. The materials selected were data and diagrams, tailored to the students' needs.

2) Design

The design stage was carried out by creating a comic storyline with data and diagrams, and by integrating literacy about peatlands and Central Kalimantan. The storyline presents two mathematical problems related to routine problems frequently faced by people in Central Kalimantan, namely forest fires (Waluyo et al., 2024). The comic storyline script was then designed by the researcher and given to the comic artist to design the comic into a 10-page comic, which was then integrated into a flipbook application. Below are some displays of the comic design results.

E-COLAND

(Kekayaan Tanah Gambut)

Di sebuah pulau yang terbesar di Indonesia yaitu pulau Kalimantan tepatnya Kalimantan Tengah hiduplah seorang anak SD yang sangat pintar dan penasaran terhadap kekayaan lingkungannya. Angre Namanya. Angre hidup di sebuah daerah yaitu Kapuas. Daerah yang dikelilingi oleh hutan gambut dan sungai yang begitu kaya akan sumber daya alamnya. (Panel 1: Pemandangan Angre lagi duduk di atas klotok, dengan pemandangan sungai dan hutan gambut). Angre hidup dengan keluarga kecil yang terdiri dari Ayah Rain, Ibu April dan Kakaknya yang Bernama Setri.

Angre : "Ayah..... !!! Kok di luar banyak kabut ?" (sambal berlari ke dalam rumah)

Ayah Rain : "Iya... kenapa teriak2?"

Angre : "Itu ayah, di luar tiba-tiba banyak asap, angre susah bernafas"

Ayah Rain : "Iya, kamu masuk, tutup pintu sama jendela, di rumah aja ya, jangan kemana-mana, sama ibu sama kakak aja disini, ayah mau melihat lahan kita"

Angre : "Ayah, angre mau ikut ke lahan"

Ayah Rain : "Yaudah, kamu emang enggak bisa diam. Ambil masker, ayok kita ke lahan, ayah khawatir lahan kita juga ikut kebakar"

(Ayah dan Angre pergi ke lahan gambut milik keluarganya, selama perjalanan, angre terus bertanya kepada ayahnya)

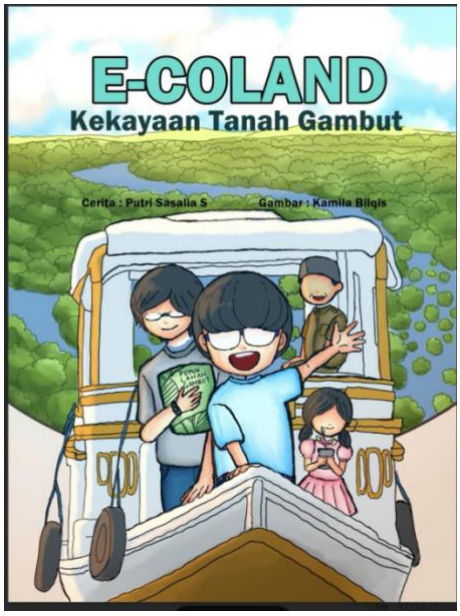
Angre : "Ayah, kenapa di Kalimantan sering terjadi kebakaran? Hampir di setiap tahun"

Ayah Rain : "Tanah kita ini berbeda dengan tanah di pulau lain. Tanah kita tanah gambut"

Angre : "Apa itu tanah gambut ayah?"

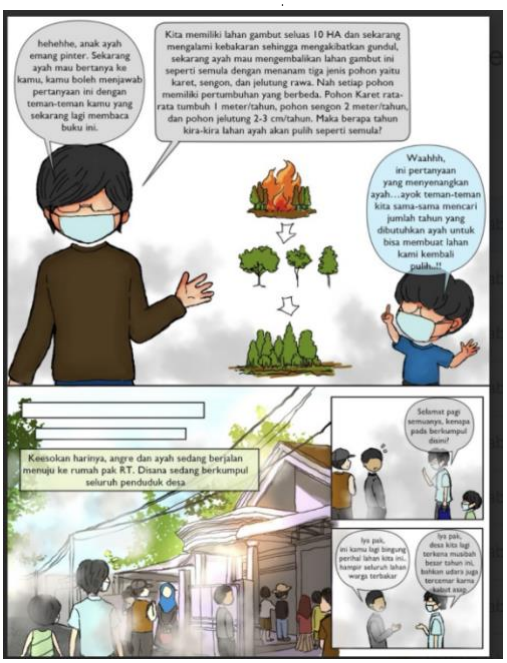
Ayah Rain : "Tanah gambut adalah jenis tanah yang terbentuk dari tumpukan berbagai bahan organik yang belum terurai secara sempurna, ya bisa

(i) Story Board of Comic



(ii) Cover

(iii) Mathematics Problems on Comic



(iv) Kalimantan Literation on Comic

3) Development

The development stage is the validation test stage by 2 validators, media experts and material experts. The material expert validation sheet was adopted from Yulaichah et al. (2024) which consists of three aspects, namely content suitability (8 statements), language (6 statements), and suitability with mathematical connection abilities (6 statements). The media expert validation sheet was adopted from Yulaichah et al. (2024) which consists of two aspects, namely graphic suitability (14 statements) and presentation aspects (4 statements). The following are the results of the material expert validation.

Table 3. Expert Validation Results

Aspect	Average V1	Average V2	Average Aspect
Content Suitability	3,63	3,75	3,69
Language	3,17	3,33	3,25
Material Suitability	4	4	4
Total Average	3,60	3,69	3,65
Percentage of Suitability	91,25%		

Based on the validation of material experts carried out by two validators on e-colands products, the average score for each aspect was as follows: the content feasibility aspect obtained an average score of 3.63 from validator 1 and 3.75 from validator 2 with an average aspect of 3.69; the language aspect obtained an average score of 3.17 from validator 2 with an average aspect of 3.25; while the material suitability aspect obtained a score of 4 from both validators with an average aspect of 4.00 (N. Susanti et al., 2025). Overall, the average score from validator 1 was 3.60, the average score from validator 2 was 3.69, so that a total average of 3.64 was obtained, if converted into a percentage, it would obtain a feasibility level of 91.25% (Suri et al., 2021). Based on the eligibility criteria, e-colands falls into the very feasible category, meaning the developed media meets the requirements of content, language, and material suitability, allowing it to be used in the learning process without significant revision. However, the experts also provided several comments and suggestions for improvements to enhance the product's quality. The content expert suggested clarifying the context of several literacy questions to better align with PISA indicators. Table 4 shows the results of the media expert validation.

Table 4. Media Expert Validation Results

Aspect	Average V1	Average V2	Average Aspect
Graphic Feasibility	3,79	3,50	3,64
Presentation	3,50	3,50	3,50
Average Total	3,64	3,50	3,57
Feasibility Percentage	89,29%		

Based on table 4, the validation results carried out by two validators on the graphic and presentation aspects obtained the following results: the graphic aspect obtained an average score of 3.79 from validator 1 and 3.50 from validator 2, so that from the two scores the average aspect was obtained at 3.64; the presentation aspect obtained an average of 3.50 from both validators, based on the two scores the average aspect was obtained at 3.50 (Harisman et al., 2023). Overall, an average score of 3.64 was obtained from validator 1 and 3.50 from validator 2 so that the total average from both validators was obtained at 3.57, if converted into a percentage, the feasibility level was 89.29%, based on the feasibility criteria the value was in the very feasible category (Mamolo, 2019a). Therefore, the developed learning media has met the criteria in terms of graphics and presentation so that the developed media is suitable for use. However, experts also suggested adjusting the color contrast of certain panels to make them easier for students to read, adding more comic pages, and toning down some illustrations for a more consistent look.

4) Implementation

The implementation stages were obtained from student responses after using the developed learning media. The purpose of this implementation was to determine the extent to which the media

was accepted by students, both in terms of content, appearance, and ease of use (Hadi et al., 2022). The following are student responses to e-colands.

Table 5. Student Response Questionnaire Results

Aspect	No. Item	Total Respondents	Total Score	Score Maximum	Average	Percentage
Content/Material Suitability	1-7	75	2106	2625	28,08	80,23
Language	8-9	75	648	750	8,64	86,40
Media Appearance/Design	10-14	75	1521	1875	20,28	81,12
User Instructions	15-16	75	629	750	8,39	83,87
Motivation & Interest in Learning	17-20	75	1133	1500	15,11	75,53
Total	1-20	75	6037	7500	80,49	407,15
Overall Percentage	**80,49**					

Based on the results of the student response questionnaire analysis on the use of e-colands in mathematics learning, the overall percentage result was 80.48%, which is included in the good category (Fianto et al., 2023). Viewed from each aspect, including the feasibility aspect of the material obtained a percentage of 80.23%, the language aspect 86.40%, the display/media design aspect 81.12%, the user instructions aspect 83.87%, and the motivation and interest in learning aspect 75.53% indicating that e-colands are considered suitable for use in learning (Siagian et al., 2024). The language aspect is higher because students consider the use of language in e-colands easy to understand, communicative, and appropriate to their developmental level, sentences in e-colands are arranged simply, not too long, and use word choices that are familiar to junior high school students (Robbani & Khoirotunnisa, 2021). Meanwhile, the lowest motivation aspect is due to learning motivation not only being influenced by the learning media, but also by the individual student's condition, classroom atmosphere, and other external factors. Some students stated that although e-colands are interesting, they still have difficulty understanding certain mathematical concepts so that their interest in learning has not increased optimally (Barut & Dursun, 2022). Most students stated that the presentation of material in the form of e-colands makes learning feel more interesting and not boring, illustrations and storylines packaged in a peat context help them more easily understand the content of the material because the appearance resembles the entertainment comics they usually read, the characters in e-colands make them more enthusiastic to participate in learning activities because the material is presented simply, and the presence of story elements that are close to everyday life is considered to help them feel more involved, thus increasing the desire to read until the end (Shafiqa et al., 2025). Based on this, the e-colands media can be used as an innovative alternative in supporting the contextual mathematics learning process, especially related to the peatland environment.

The research results indicate that e-colands is considered appropriate in terms of material, media, language, and presentation. However, when compared with previous research findings, these results show some agreement and differences. Studies related to e-colands, such as those by Rahmawati (2022) and (Kurniawan et al., 2025), generally confirm that e-colands can increase student interest and understanding through engaging visualizations and storylines. The findings of this study are consistent, particularly in the language and presentation aspects, which received high scores. However, the lower motivation score (75.53%) indicates that e-colands alone is not sufficient to maximally increase learning motivation. This contrasts with the findings of Lestari et al. (2021), who reported a more significant increase in motivation through comics based on local stories. This difference may be due to the

complexity of the mathematical literacy material in the peatland context, which demands higher reasoning skills, so not all students experience an immediate increase in motivation.

From a Realistic Mathematics Education (RME) perspective, the e-colands developed in this study have essentially fulfilled two core principles of RME, namely contextualization and guided reinvention. The principle of contextualization is reflected in the presentation of mathematical problems embedded in peatland-related issues that are closely connected to students' daily lives in Central Kalimantan, such as forest fires and peatland environmental characteristics (Flood et al., 2025). These real-world contexts enable students to perceive mathematics not merely as a collection of abstract formulas, but as a practical tool for understanding and solving problems that are relevant to their surrounding environment (Kohen & Orenstein, 2021). In this sense, the use of peatland contexts supports meaningful learning by bridging mathematical concepts with students' lived experiences (Flood et al., 2021). The principle of guided reinvention is also partially implemented through storylines and problem situations that encourage students to reconstruct mathematical ideas through contextual narratives (Solomon et al., 2021). However, the application of RME principles in e-colands has not yet been fully optimized. The storyline and mathematical activities remain relatively limited in guiding students to independently discover concepts through a gradual exploration process. This limitation may explain why the increase in students' learning motivation, particularly in the motivation and interest aspect, was not as strong as expected. As noted by Susanti (2025), effective RME implementation requires learning activities that actively engage students in progressive discovery and reasoning, rather than merely presenting contextual problems.

In terms of media design, student responses indicate that the visual appearance of e-colands is attractive, communicative, and similar to entertainment comics that students commonly read. Engaging visuals play an important role in capturing students' initial interest and reducing learning boredom (Chevalère et al., 2023). Nevertheless, several students suggested that certain sections still lack opportunities for active engagement. Features such as exploratory tasks, reflective questions, or more varied problem-solving activities were identified as necessary to enhance student interaction with the content. This finding is consistent with Matuk et al. (2021), who emphasize that comics used in educational settings are most effective when visual narratives are combined with structured tasks that promote student reflection and participation. Therefore, effective e-colands design should not rely solely on appealing visuals and contextual narratives, but also incorporate well-structured mathematical tasks that provide gradual cognitive challenges. Such task structures can help students build conceptual understanding step by step, strengthen their mathematical reasoning, and enhance overall mathematical literacy. By integrating progressive levels of difficulty, e-colands can function not only as a reading medium but also as an interactive learning tool that supports active mathematical thinking.

Overall, the findings of this study suggest that e-colands based on Realistic Mathematics Education (RME), particularly within the peatland context, have strong potential as an alternative learning medium to support students' mathematical understanding and literacy. However, improving students' learning motivation requires additional pedagogical interventions. These include strengthening RME-based activities, integrating classroom discussions, and providing continuous teacher support during media use. Teachers play a crucial role in facilitating discussions, offering scaffolding, and guiding students to reflect on their mathematical thinking processes. Consequently, future e-colands development is recommended to carefully integrate visual design, narrative elements, and mathematical activity structures to maximize their impact on both student motivation and mathematical literacy.

4. CONCLUSION

Based on the research results and discussion, the development of e-colands (Electronic Comic of Peatlands) to improve junior high school students' mathematical literacy was declared valid and practical. The e-colands product developed through the four-stage ADDIE model obtained an average feasibility score of 89% from material and media experts, thus categorized as very feasible for use in mathematics learning. In addition, student responses showed an average score of 80% in the good category, indicating that the product is easy to use and accepted by students. Although the research results showed success, this development has several limitations. First, the trial was only conducted on a limited scale and did not involve schools with different characteristics. Second, the learning process using e-colands was carried out in a relatively short time, so its impact on student learning motivation was not optimal. Third, the interactive features in e-colands are still limited so they do not fully accommodate the RME principle and students' exploratory activities. The implication is that mathematics teachers can utilize e-colands as an alternative medium to introduce mathematical concepts that require strong visualization and real context, especially related to local issues in Central Kalimantan such as peatlands. Furthermore, the use of contextual comics can be an additional strategy to strengthen mathematical literacy in the Independent Curriculum, which emphasizes problem-based learning and life contexts. For future researchers, it is recommended to conduct larger-scale effectiveness tests, develop e-colands for other mathematics materials, and add interactive features such as reflective questions, simple simulations, or short videos to further enhance student motivation. Furthermore, a more in-depth analysis of the influence of visual design, storyline, and ethnomathematics context on student literacy is also needed to produce a more comprehensive product.

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