Journal of Mathematics Instruction, Social Research and Opinion
Vol. 5, No. 3, September 2026, pp. 2509 – 2526, https://doi.org/10.58421/misro.v5i3.2111
ISSN 2962-7842

Development of Interactive Digital Comics Based on Local Environmental Wisdom for Flood Literacy in Elementary Social Studies

Cut Kumala Sari[1], Ikrima Maulida[2], Eci Anita Lestari[3], Rapita Aprilia[4], Arif Arbi Auliya[5]
[1,2,3,4,5]Universitas Samudra, Langsa, Indonesia

Article Info

Article history:

Received 2026-09-09
Revised 2026-09-24
Accepted 2026-09-30

Keywords:

ADDIE
Digital comic
Elementary school
Flood learning
Local environmental wisdom
Science literacy

ABSTRACT

Flood-related learning in elementary schools requires contextual and engaging media that can connect scientific concepts with students' local environmental experiences. However, digital learning media that integrates local environmental wisdom into interactive flood learning remains limited. This study aimed to develop and evaluate an interactive digital comic based on local environmental wisdom for flood-related social studies learning in elementary school. Using a Research and Development approach with the ADDIE model, the study involved elementary school students and teachers, supported by three expert validators in material, media, and language. Data were collected through validation sheets, teacher and student practicality questionnaires, and pretest–posttest assessments. Data were analyzed using descriptive statistics and N-gain analysis. The results showed that the digital comic achieved an average validity score of 91%, categorized as very valid, and an average practicality score of 91%, categorized as very practical. Students' average posttest score was higher than the pretest score, increasing from 58.50 to 82.75, with an N-gain of 0.58, categorized as moderate. The findings indicate that the developed digital comic is feasible and practical for contextual flood learning, while the observed score improvement provides preliminary evidence for further effectiveness testing. The study contributes a locally contextualized digital learning medium that integrates environmental wisdom into interactive science learning.

This is an open-access article under the CC BY-SA license.

Corresponding Author:

Cut Kumala Sari
Faculty of Teacher Training and Education, Elementary School Teacher Education, Universitas Samudra, Langsa, Indonesia
Email: cutkumalasari79@unsam.ac.id

1. INTRODUCTION

Learning at the elementary school level is not just about providing knowledge, but also aimed at developing students' abilities to understand information, think critically, and connect learning materials to everyday life. In this context, environmental learning is

particularly important because students need to understand environmental phenomena that are closely related to their daily lives. Learning about floods needs to be linked to students' environmental conditions and real experiences so that they not only understand the concept of floods but also can recognize the risks, impacts, and efforts [1]. Floods are environmental problems that often occur and can affect people's lives. Therefore, learning about floods needs to be delivered contextually so that students are encouraged not only to understand flood-related concepts but also to identify causes, recognize potential impacts, and understand appropriate prevention and preparedness efforts. The flood material that can be provided to students includes discussions on the causes of floods, the impacts they cause, as well as steps and preparedness that can be done before, during, and after a disaster [2].

According to [3], students' knowledge and understanding of flood disasters need to be improved because it is still commonly found that elementary school students do not have knowledge about floods. In social studies lessons, materials about the environment can serve as a means to foster students' concern for the conditions of their surroundings. Social studies lessons are already mandatory for students starting from elementary school [4]. However, the delivery of material, which is still dominated by textbooks and teacher explanations, can make students less interested and have difficulty relating the material to real-life situations. This condition indicates the need for learning media that can present environmental issues in a form that is accessible, engaging, and closely connected to students' experiences. Choosing interesting media that fits students' characteristics can support a more active learning process that is meaningful for them.

Interactive digital comics can be a media option that supports delivering material to students. Interactive digital comics present learning content through a combination of narrative, images, text, and interactive activities, allowing students to engage with the material more contextually and appealingly. According to [5], interactive digital comics can help students understand the material because the information is conveyed through visual, text, and audiovisual elements. The presence of interactive components also gives students the opportunity to be more actively involved during the learning process. Thus, interactive digital comics have potential not only as a means of presenting information but also as a learning environment that can encourage students to read, interpret visual information, follow narratives, and respond to learning activities.

The digital comic developed in this study incorporates elements of local wisdom found in the students' surroundings. The local environmental wisdom incorporated into the comic refers to locally familiar knowledge, values, practices, and environmental behaviors that can be associated with how communities understand, respond to, and care for their surrounding environment. These elements are presented through the context of the students' local environment so that flood-related concepts are not presented as abstract information but are connected to situations and environmental practices that students can recognize. The use of this context is intended so that flood material can be connected to situations close to the students' experiences. Utilizing local wisdom in social studies learning can become a source of contextual learning that is close to students' lives, making learning more meaningful and relevant to social and cultural environments [6]. In the context of flood education, connecting local wisdom with environmental issues is relevant because students

can recognize that community knowledge and environmental practices can be related to awareness, preparedness, and responsible behavior toward flood risks. In this way, students can see that environmental issues are not just material learned from books but can also be found in everyday life. Integrating local wisdom into digital learning media can make the material more engaging and help students understand lessons through cultural contexts they are familiar with [7].

Besides understanding the material, learning also needs to support the improvement of students' literacy and science comprehension. Digital comics can also be used as an innovative learning medium to support the development of literacy and creative thinking in elementary school students [8]. Students are expected to be able to read information, understand environmental phenomena, connect cause and effect, and use the knowledge they gain to solve simple problems related to the environment. Interactive digital comics that present flooding issues through stories and learning activities are expected to help students develop these skills. Therefore, integrating flood education, local environmental wisdom, and interactive digital media provides an opportunity to develop learning materials that simultaneously address literacy, environmental understanding, and students' ability to relate learning content to real situations.

Although previous studies have established the potential of interactive digital comics for supporting learning and have highlighted the relevance of local wisdom in contextual learning, an important gap remains in the development of digital learning media that specifically integrates flood education with local environmental wisdom in elementary social studies. Previous discussions tend to emphasize the usefulness of digital comics as learning media or the contextual value of local wisdom separately, while the combination of flood-related content, local environmental wisdom, interactive digital comic features, and social studies learning remains insufficiently addressed in the present context. This gap is particularly relevant because flood education requires students to understand environmental risks through situations that are meaningful and recognizable in their own surroundings.

The novelty of this study lies in the integration of these elements into a single interactive digital learning medium. Rather than presenting flood material only through general explanations, the developed digital comic incorporates local environmental wisdom into narratives and learning activities so that students can encounter flood-related concepts through familiar environmental and cultural contexts. The study therefore positions local wisdom not merely as an additional illustration or cultural element, but as part of the contextual basis for presenting flood education in elementary social studies.

Based on these issues, this study focuses on the development of interactive digital comics that utilize local wisdom from the environment in social studies learning to support the improvement of literacy and students' understanding of science in elementary schools. Specifically, this study aims to develop an interactive digital comic that integrates flood-related learning content with local environmental wisdom and to examine its feasibility as a learning medium for elementary school students. Using digital comics that integrate local wisdom can be an alternative learning medium that connects the material with cultural and environmental contexts close to students' lives. The study is expected to contribute to the development of contextual social studies learning media by demonstrating how local

environmental wisdom can be integrated into interactive digital comics for flood education. Practically, the developed medium is expected to provide teachers with an alternative resource for presenting environmental and disaster-related content in a form that is more relevant to students' everyday experiences. In addition, the development of digital comics based on local wisdom in social studies learning also shows potential as an innovative learning medium that can be used to support the learning process. The developed products are expected to be feasible in terms of validity, practicality, and effectiveness so that they can be used as an alternative learning medium for social studies at the elementary level.

2. METHOD

2.1. Research Design

This study uses a research and development (R&D) design aimed at producing and examining the feasibility, practicality, and preliminary effectiveness of interactive digital comics based on local environmental wisdom for social studies learning on flood material. The product development uses the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. These five stages are carried out systematically, starting from identifying learning needs and contextual problems, followed by product design and development, implementation with students, and evaluation of the developed product [11].

The ADDIE model is used because its development process is carried out through systematic, sequential, and interconnected stages. The process starts with identifying learning needs and student characteristics, continues with designing and developing the product, and is followed by implementation and evaluation to determine the quality and use of the developed learning medium. [12] Explain that ADDIE can be used as one of the models in development research because it provides clear stages from needs analysis to product evaluation.

The development and evaluation procedures in this study were organized into five stages, as described in Sections 2.2–2.6.

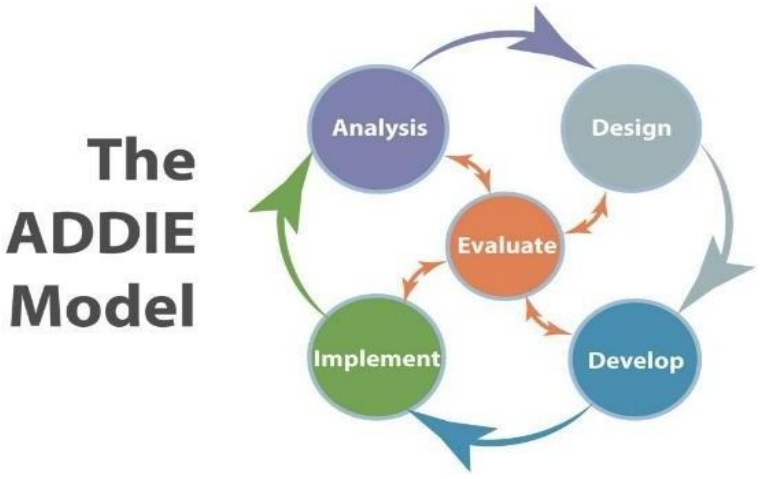


Figure 1. ADDIE Model

2.2. Analysis Stage

The analysis stage is carried out to identify the needs and learning problems related to the development of social studies learning media on flood material. The analysis includes needs analysis, student characteristics, curriculum analysis, material analysis, and learning media analysis. This analysis is conducted through observations and interviews with teachers, as well as a study of the curriculum and learning materials. This stage is necessary to ensure that the media developed matches the students' needs, learning characteristics, and issues found in the field [13].

The results of the analysis also serve as the basis for determining the design of interactive digital comics that fit the students' characteristics, learning goals, and the surrounding environmental conditions. The flood material will then be linked to local environmental wisdom found in the students' surrounding environment so that learning becomes more contextual and closer to the students' daily lives.

The local environmental wisdom content was selected based on its relevance to the surrounding environmental context and its relationship to flood prevention, preparedness, and responsible environmental behavior. The selected elements were incorporated into the storyline and learning activities of the digital comic to provide students with contextual examples that are close to their everyday experiences.

2.3 Design Stage

In this design stage, the process starts with designing the product based on the results of the analysis. This stage can be done by preparing the materials, layout designs, product flow, and instruments that will be used in the research [14]. At this stage, the learning objectives, flood materials, elements of local wisdom, storyline, characters, illustrations, and interactive elements suitable for elementary school students are determined.

The product design includes the learning flow, storyline, presentation of flood-related concepts, integration of local environmental wisdom, visual illustrations, characters, navigation, and interactive learning activities. The design was developed to ensure that the content, visual presentation, language, and interactive elements were appropriate for elementary school students.

In addition, validation instruments, teacher and student response questionnaires, as well as literacy and science comprehension tests, were also prepared as research instruments.

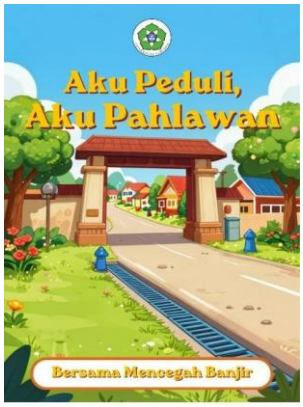


Figure 2. Preliminary design

2.4. Development Stage

According to [15], this stage is the process of realizing the design into a usable product. The product is then validated by experts to determine its feasibility and to get suggestions for improvements. The development stage involves creating interactive digital comics based on local wisdom, following the design from the design stage. The developed prototype was reviewed and revised based on expert feedback before being implemented with students.

The product is assessed by content experts and media experts to determine its level of feasibility. The feedback given through the validation process is used as a reference for making revisions before the media is applied to students.

Besides validating the content and media, the product will also be validated by a language expert. Language validation aims to assess whether the language used in the interactive digital comic is suitable for elementary school students. The aspects evaluated include clarity of sentences, readability, use of communicative language, and whether the language matches the students' developmental level. Language expert validation is needed to ensure that the language used in the comic media can be understood by students and suits their characteristics [16].

The validity score was calculated by comparing the obtained score with the maximum possible score and expressing the result as a percentage. The validation results were then interpreted according to the validity criteria used in the study.

2.5. Implementation Stage

The implementation stage is the process of applying the interactive digital comic media that has been developed and validated by experts to the students. The product is tested to find out its practicality and the students' responses to the media that has been developed. According to [17], the implementation stage is carried out by applying the product that has been developed and validated by experts to the students as users. The purpose of this stage is to obtain information regarding the use and response to the product when applied in learning activities.

Practicality was assessed through teacher and student response questionnaires. The questionnaires were used to obtain information about the ease of use, attractiveness, clarity, and usefulness of the developed interactive digital comic. The practicality scores were calculated by comparing the obtained score with the maximum possible score and expressing the result as a percentage. The results were then interpreted according to the practicality criteria used in the study.

To examine changes in students' literacy and science comprehension, this study used a one-group pretest–posttest design, represented as O_1–X–O_2, where O_1 represents the pretest, X represents learning using the interactive digital comic, and O_2 represents the posttest. The tests were administered before and after the implementation of the learning media.

The normalized gain (N-gain) was calculated using the following formula:

$$N - Gain = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}} \quad (1)$$

The N-gain results were used to describe the level of improvement in students' literacy and science comprehension following the implementation of the interactive digital comic. Because this study used a one-group pretest–posttest design without a control group, any observed increase in scores was interpreted as improvement following implementation rather than definitive evidence that the digital comic alone caused the improvement.

2.6. Evaluation Stage

According to [17], the evaluation stage is conducted to assess the product based on data obtained during the development and implementation process. The goal is to gather data on how the product is used in learning. In this study, the evaluation stage integrates the results of expert validation, teacher and student practicality responses, and the pretest–posttest results.

This stage is about assessing the interactive digital comic that has been developed based on the results of validation and testing to determine the feasibility and practicality of the product. The evaluation also considers the preliminary effectiveness of the product based on changes in students' literacy and science comprehension scores. The results of validation, practicality assessment, and pretest–posttest data are used to determine whether revisions are required.

Thus, the evaluation stage examines three aspects of the developed product: validity, practicality, and preliminary effectiveness. The findings from the evaluation are used as the basis for improving the interactive digital comic and determining its suitability as an alternative learning medium.

2.7. Research Instruments

The research instruments consisted of expert validation questionnaires, teacher and student response questionnaires, observation and interview guidelines, and literacy and science comprehension tests. The expert validation questionnaires were used to assess the content, media, and language aspects of the product. The teacher and student questionnaires were used to assess the practicality of the media, while the pretest and posttest were used to measure changes in students' literacy and science comprehension.

The validation, practicality, and learning assessment instruments were developed based on the objectives and indicators of the study. The questionnaires used a Likert-type scoring system, while the literacy and science comprehension tests were administered before and after the implementation of the digital comic.

2.8. Data Collection Procedure

Data were collected through observation, teacher interviews, expert validation, teacher and student response questionnaires, and pretest and posttest administration. Observation and interviews were conducted during the analysis stage to identify learning needs, student characteristics, learning conditions, and problems related to flood learning.

After the prototype was developed, expert validation was conducted to assess the content, media, and language aspects. The product was revised based on the validation results before being implemented in learning activities. During implementation, students

used the interactive digital comic for social studies learning on flood material, followed by the collection of teacher and student responses.

The pretest was administered before students used the digital comic, while the posttest was administered after the learning activities. The pretest and posttest results were used to identify changes in students' literacy and science comprehension.

2.9. Data Analysis

The data were analyzed descriptively using percentages for the expert validation and practicality assessments. The percentage was calculated by comparing the obtained score with the maximum possible score. The resulting percentages were interpreted according to the predetermined validity and practicality criteria.

Pretest and posttest scores were analyzed using descriptive statistics and N-gain to identify changes in students' literacy and science comprehension. The N-gain was calculated using the difference between the posttest and pretest scores relative to the maximum possible improvement.

If inferential analysis is conducted, the paired-sample t-test can be used when the data meet the assumptions of parametric analysis, while the Wilcoxon signed-rank test can be used when those assumptions are not met. Effect size can also be reported to describe the magnitude of the observed pretest–posttest change.

Because the study does not include a control group, the statistical results are interpreted as evidence of changes observed following the implementation of the digital comic rather than definitive evidence of a causal effect of the intervention.

2.10. Ethical Considerations

Because the study involved elementary school students, ethical procedures were applied throughout the research. Permission to conduct the study was obtained from the relevant school. Parents or legal guardians were informed about the study and provided consent for student participation, while students were informed about the study using language appropriate to their age. Participation was voluntary, and participant information was kept confidential. The collected data were used only for research purposes, and students' identities were not disclosed in reporting the research findings

3. RESULTS

This section presents the findings of the interactive digital comic development using the ADDIE model. The results are presented according to the five development stages: analysis, design, development, implementation, and evaluation. The findings include the needs identified in the analysis stage, the characteristics of the developed product, expert validation results, teacher and student responses, and changes in students' literacy and science comprehension following implementation.

3.1. Analysis Stage Results

Needs analysis shows that there is a demand for learning media that can deliver flood material in a contextual way with presentations that are engaging for students. Based on

observations and interviews with teachers, the identified learning needs included the need for media that could connect flood-related concepts with students' surrounding environmental conditions, present information in a more engaging format, and provide contextual examples that students could relate to. Learning about floods still requires digital media that can connect the material with the actual conditions in students' environments.

The results of this analysis became the basis for developing interactive digital comics based on local wisdom from students' surroundings. The local environmental wisdom was integrated into the learning context by presenting environmental situations, community practices, and values related to environmental care and flood prevention. This integration was intended to help students relate flood concepts to conditions and practices that are familiar in their everyday lives. The comics are designed to include environmental situations related to floods as well as the values contained within them. This aligns with research conducted by [18], which found that at the analysis stage, the media used need to have interesting and interactive elements and be adjusted to the characteristics of elementary school students.

3.2. Design Stage Results

At this stage, an initial draft of the digital comic is produced, which includes the opening page, user instructions, character introductions, stories about the environment, presentation of flood-related material, integration of local wisdom, interactive questions, exercises, reflections, and evaluations. The storyline was designed to connect the presentation of flood material with environmental situations that are familiar to students. The local environmental wisdom component was incorporated into the storyline and learning activities rather than being presented only as an additional illustration.

The comic is designed using illustrations and language that suit the characteristics of elementary school students. The interactive elements provide opportunities for students to read the narrative, observe visual information, respond to questions, complete exercises, and reflect on the material. These features were intended to support the presentation of flood literacy through a combination of narrative, visual, and interactive information. In the study conducted by [19], digital comic media was designed by adjusting the material, student characteristics, learning objectives, and appealing visuals. Figure 2 presents the preliminary design of the interactive digital comic, including its storyline, visual presentation, learning content, and interactive components.

3.3. Development Stage Results

The initial product was then further developed and validated by content experts and media experts. Validation was conducted to determine the feasibility of the product based on aspects of content, language, appearance, presentation, and interactivity. The validation results were used as a basis for making improvements to the product before it was applied to students.

The product was evaluated by a material expert, a media expert, and a language expert. The material expert assessed the suitability and accuracy of the learning content, the

media expert assessed the visual and interactive aspects, and the language expert assessed the clarity and appropriateness of the language for elementary school students.

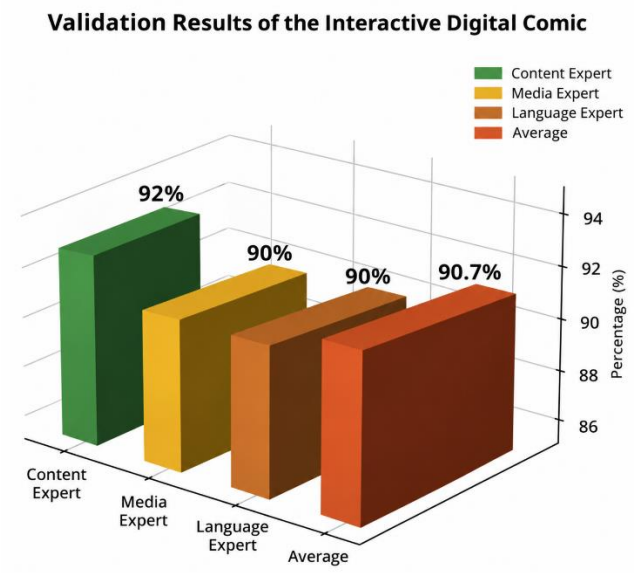


Figure 3. Results of interactive digital comic validation

The assessment results from the validators showed that the media received a validity score of 91% and falls into the very valid category. The material expert gave a score of 92%, the media expert gave 90%, and the language expert gave 90%, resulting in an average validity score of 91%. The validator also gave some feedback that was used as a basis for making product improvements. The revisions focused on improving the product based on the experts' comments concerning the content, presentation, visual/media aspects, and language. The revised product was subsequently used in the implementation stage.

Table 1. Product validation results

SN.	Validator	Percentage	Category
1.	Material Expert: Rapita Apriia	92%	Very Valid
2.	Media Expert: Maisarah	90%	Very Valid
3.	Language Expert: Ikrima Maulida	90%	Very Valid
	Average	91%	Very Valid

In the implementation stage, interactive digital comic media was used directly in the learning process [20]. The revised product was then implemented for 3rd-grade students, carried out in the social studies class on the topic of floods using interactive digital comics. During implementation, students interacted with the comic through its narrative, illustrations, learning content, questions, exercises, and reflection activities. Afterwards, teachers and students provided feedback on the use of the media.



Figure 4. Teacher and student response

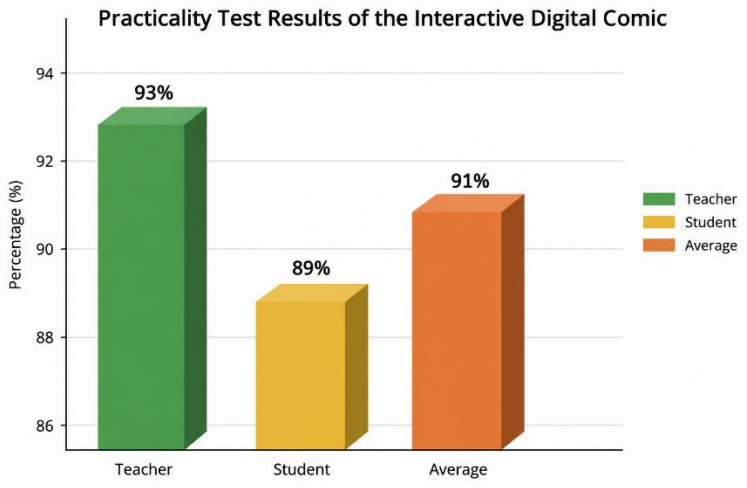


Figure 5. Results of the practicality test of the interactive digital comic

Based on the results of the teacher response survey, a percentage of 93% was obtained, student responses reached 89%, and the average score was 91%, indicating that the media is in the very practical category, with the responses indicating that the media was easy to use, engaging, and supportive of learning flood material in social studies lessons. These results align with the research [21], which showed that digital comics got a 94% response from teachers and 93.25% from students, with an average practicality of 93.6%, in the very practical category.

Table 2. Teacher and student response results

SN.	Respondent	Persentage	Category
1.	Teacher	93%	Very Practical
2.	Student	89%	Very Practical
	Average	91%	Very Practical

The preliminary effectiveness of the product was examined by comparing students' literacy and science comprehension scores before and after using the interactive digital

comic. A one-group pretest–posttest design was used to identify changes in students' scores following implementation. The use of pretests and posttests is also applied in the development research of digital comics based on local wisdom to find out the improvement in students' science literacy [22].

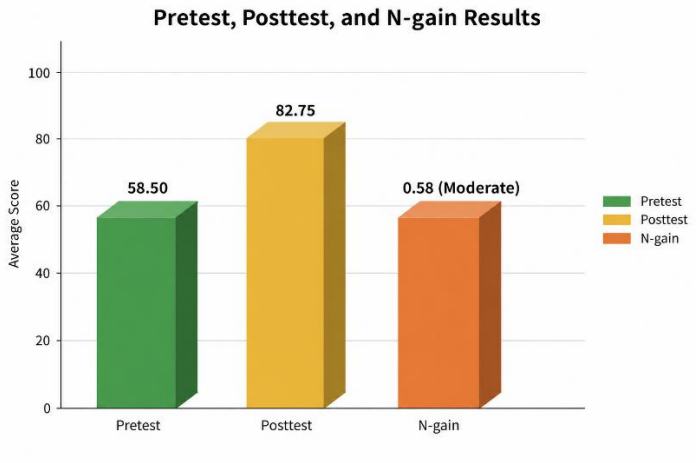


Figure 6. Results of pretest, posttest, and N-gain

Table 3. Results of pretest, posttest, and N-gain

Data	Average Score
Pretest	58,50
Posttest	82,75
N-gain	0,58
Category	Medium

Based on the test results, the students' average pretest score was 58.50, while the average posttest score increased to 82.75. The N-gain calculation gave a value of 0.58, which falls into the medium category. Thus, students showed higher posttest scores after using the interactive digital comic, with a moderate N-gain. These results indicate an observed improvement in students' literacy and science comprehension following implementation of the learning media. However, because the study used a one-group pretest–posttest design without a comparison group, the increase cannot be interpreted as definitive evidence that the digital comic alone caused the improvement. This aligns with research conducted by [23], which shows that using science comic media can improve elementary students' science literacy.

3.6. Evaluation Stage Results

The evaluation stage was carried out by reviewing all the results obtained during the development process, starting from analysis, design, development, up to product implementation. The evaluation integrated the findings from expert validation, teacher and student responses, and pretest–posttest results. Validation results showed that the interactive digital comic based on local environmental wisdom is in the very valid category, while the responses from teachers and students indicated it is very practical.

Additionally, the results from the pretest and posttest showed an increase in students' literacy and science understanding, with an N-gain score of 0.58, which is in the moderate category. Taken together, these findings indicate that the developed interactive digital comic met the predetermined indicators of validity and practicality and showed an observed improvement in students' scores after implementation. According to [19], the evaluation stage is carried out to identify the strengths and weaknesses of the product after it is used in learning.

The evaluation results provide a basis for further refinement of the media, particularly in relation to the presentation of local environmental wisdom, interactive learning activities, and the clarity of flood-related content.

3.7. Summary of Key Findings

Overall, the findings indicate that the interactive digital comic based on local environmental wisdom obtained a very valid assessment, with an average validation score of 91%. Teacher and student responses produced an average practicality score of 91%, categorized as very practical. The average student score increased from 58.50 in the pretest to 82.75 in the posttest, with an N-gain of 0.58 in the medium category. These findings provide evidence of product feasibility and practicality and indicate an observed improvement in learning scores following implementation.

4. DISCUSSION

The development of interactive digital comics based on local environmental wisdom was carried out in five ADDIE stages: analysis, design, development, implementation, and evaluation. Rather than functioning only as a sequence of product-development procedures, the five stages provided a systematic process for connecting students' learning needs, flood-related content, local environmental context, and interactive digital features. The development process was carried out through structured stages with the aim of producing learning media that is relevant to students' needs and suitable for use in the learning process [24].

In the analysis stage, it was found that there is a need for more engaging and contextual learning media. The need for contextualization is particularly relevant to flood learning because students can encounter environmental risks and conditions directly in their surroundings. Presenting flood material through familiar environmental situations can therefore provide a bridge between conceptual information and students' everyday experiences. This situation became the basis for developing digital media that integrates flood materials with the environment around the students. In the study [25], analysis findings showed that presenting material through interactive digital comics can help students understand learning concepts, especially because the material is packaged in a narrative that relates to everyday life situations.

Next, in the design stage, the comic is created by taking into account the learning material, student characteristics, story flow, visual appearance, and interactive elements. Using images and stories makes the material easier for students to follow, while elements of local wisdom provide a contextual layer that connects the learning content with students'

surrounding environmental and cultural experiences. The interactive digital comic media is designed based on the results of a needs analysis, and its design covers topics like flooding, story flow, storyboard, characters, and their appearance [26].

The integration of local environmental wisdom is particularly important because it distinguishes the developed product from a digital comic that presents flood material only through general environmental information. In this product, local wisdom is positioned within the learning narrative and activities so that students can encounter environmental values and practices while learning about floods. This approach allows flood education to be connected not only with scientific information about environmental phenomena but also with students' understanding of how people interact with and care for their environment.

At the implementation stage, the product is used in the learning process, and feedback is gathered from teachers and students. This feedback is used to determine how practical the product is. Furthermore, integrating local environmental wisdom into the comic provides a context that is close to students' lives. Students not only learn about floods as a concept, but also understand the relationship between environmental conditions, human activities, and efforts to take care of the environment. According to [27], integrating environmental context into learning media can help students understand the lessons better, in a contextual and meaningful way.

The research results show that interactive digital comics based on local environmental wisdom developed for flood material have a good level of feasibility for use in elementary school social studies learning. Validation results on content/material, language, and format/display all fall into the very valid category. This indicates that the material presented aligns with the learning objectives, the language is understandable for students, and the comic's appearance supports the delivery of the material. According to the research conducted by [28], the media, material, and language validation results are declared very valid and suitable for use.

The high validation scores suggest that the product components were generally aligned with the criteria assessed by the three validators. Nevertheless, validation primarily indicates the appropriateness of the developed product according to expert judgment and should be distinguished from evidence of learning effectiveness.

From a practical standpoint, teacher and student responses show a very practical category. Interactive digital comics can be easily used in the learning process and provide a more contextual and engaging learning experience. The combination of narrative, visual presentation, and interactive activities may make the learning process more accessible to elementary school students because information is presented through multiple forms rather than through text-based explanation alone. The use of local environmental wisdom elements also helps in connecting flood material with the environmental conditions close to students' daily lives. This aligns with research conducted by [29], which shows that interactive digital comics can be practically used in teaching about the environment in elementary schools.

Furthermore, the results of the pretest and posttest show an improvement in students' abilities. The average score increased from 58.50 to 82.75, with an N-gain score of 0.58, which falls into the medium category. This moderate N-gain indicates that the improvement was not in the highest category and suggests that there remains room for further improvement

in the learning process and media design. Factors such as students' familiarity with digital learning, the duration of implementation, opportunities for interaction, and the complexity of flood-related concepts may influence the extent of observed improvement. These results also indicate that the use of interactive digital comics was associated with higher posttest scores in students' scientific literacy and understanding in flood-related materials. These findings align with research [30] showing that the use of digital comics in instruction can improve the learning outcomes of elementary school students, with an N-gain score of 0.663—falling into the medium category—and demonstrating a difference in results.

The findings can be understood through the complementary functions of narrative, visual information, interactivity, and contextual content. The narrative structure can help organize flood-related information into a sequence that students can follow, while illustrations can provide visual representations of environmental situations. Interactive questions and exercises can provide opportunities for students to respond to the content, whereas local environmental wisdom can make the learning context more familiar and meaningful. These components may work together to support students' engagement with flood-related information, although the present design does not allow their individual contributions to be isolated.

The role of local environmental wisdom is also important in interpreting the findings. Its integration provides a contextual connection between flood concepts and students' surrounding environment, allowing environmental responsibility and flood-related practices to be presented through situations that are closer to students' experiences. In this sense, local wisdom functions not simply as a cultural decoration but as a contextual resource for presenting environmental learning.

The observed improvement should nevertheless be interpreted cautiously. The study used a single-group pretest–posttest design without a control group, so changes in scores may also be influenced by factors other than the digital comic, such as students' prior learning, classroom interaction, teacher support, repeated exposure to the material, or normal learning progression. Therefore, the present findings provide preliminary evidence of improvement following implementation rather than conclusive evidence of a causal effect.

Several limitations should also be considered. First, the study was conducted in a limited educational context, which restricts the generalizability of the findings to other elementary schools and student populations. Second, the absence of a control or comparison group prevents a strong causal interpretation of the pretest–posttest improvement. Third, the use of N-gain as a primary indicator of change provides information about score improvement but does not fully explain the mechanisms underlying the observed learning changes. Future studies could involve a larger and more diverse sample, include a comparison group, apply the media over a longer period, and examine literacy and science comprehension as separate outcomes using more comprehensive inferential analyses.

Overall, the findings suggest that the interactive digital comic provides a feasible and practical medium for presenting flood-related social studies content through a combination of digital narrative, visual information, interactive activities, and local environmental wisdom. The contribution of the study lies particularly in integrating these elements into a

contextual learning medium rather than presenting flood material solely through conventional digital content.

5. CONCLUSION

This study developed an interactive digital comic based on local environmental wisdom for flood-related social studies learning in elementary school using the ADDIE model. The developed product was rated very valid with an average validation score of 91% and very practical with an average teacher and student response score of 91%. Students also showed higher posttest scores after implementation, increasing from an average of 58.50 to 82.75, with an N-gain of 0.58 in the moderate category. These findings indicate that the product met the assessed criteria of feasibility and practicality and was associated with an observed improvement in students' learning scores.

The study contributes to the development of contextual digital learning media by integrating digital narrative, visual presentation, interactive activities, and local environmental wisdom into flood-related learning. This approach can provide elementary school teachers with an additional learning resource for connecting environmental concepts with students' everyday contexts. However, the findings should be interpreted within the context of the participating elementary school and students. The use of a one-group pretest–posttest design without a control or comparison group limits causal interpretation, and the limited educational context restricts the generalizability of the findings.

Future research should involve larger and more diverse elementary-school samples, comparison groups, and longer implementation periods to provide stronger evidence of learning changes. Further studies should also examine separately whether the digital comic supports flood literacy, science literacy, environmental awareness, and disaster preparedness, as well as investigate the specific contribution of local environmental wisdom to these outcomes.

ACKNOWLEDGEMENTS

Sincere thanks for the research grant that has been awarded to the research team under contract number 773/DST/UN54.6/PT.01.03/2026 DIPA budget of Samudra University in 2026. This financial support has not only provided an opportunity to continue my research but has also been a great encouragement in the development of my ideas and concepts.

REFERENCES

[1] A. D. Khairullah, F. M. Firdaus, and H. N. Mawaddah, "The effect of eco-pedagogy-based learning on disaster mitigation literacy of students at SDN 2 Percontohan Aceh Tamiang," *Pedagogik: Journal of Elementary School Teacher Education*, vol. XIV, no. 1, pp. 172–183, 2026.

[2] B. Leny, S. Puspitasari, A. Praja, R. Nadia, R. Aggriani, R. Anissauqi, *et al*., "Socialization of flood disaster mitigation at SDN 2 Bagik Papan Pringgabaya, East Lombok," *Health Service Hub*, vol. 2, no. 3, pp. 1–3, 2025.

[3] M. Daniarista, I. Sarifah, and C. B. Yudha, "Analysis of factors causing low knowledge of elementary school students about flood mitigation," *Pendas: Scientific Journal of Basic Education*, vol. 9, no. 2, 2024.

[4] C. K. Sari, "Urgency of understanding basic social studies concepts for PGSD students," *Pendas: Scientific Journal of Basic Education*, vol. 9, no. 2, 2024.

[5] T. A. Aufa and F. Y. Satriyani, "Development of interactive digital comics based on audiovisuals in Indonesian language lessons to improve reading comprehension skills of fourth grade students at SDN 09 Pagi Duren Tiga Jakarta," *Pendas: Scientific Journal of Basic Education,* vol. 11, no. 1, 2026.
[6] I. Nurjanah, W. D. Puspitasari, B. Febriyanto, and A. Rosidah, "Utilization of local wisdom in social studies learning in elementary schools: A systematic literature review," *Pendas: Journal of Basic Education Science*, vol. 11, no. 1, 2026.
[7] K. S. W. Diatmika, N. M. Asril, and N. W. Rati, "Digital comic learning media based on Subak local wisdom to increase students' interest in learning about the water cycle in fifth grade elementary school," *Indonesian Multicultural Education Journal,* vol. 8, no. 1, pp. 1–11, 2025.
[8] T. M. R. Andriani and Gunawan, "Development of digital comic media to improve reading and writing literacy and creative thinking of elementary school students," *Education Publication Journal,* vol. 16, no. 2, pp. 775–784, 2026.
[9] N. P. E. Lianasari, I. G. A. Astawan, and G. A. P. S. Trisna, "Development of Tri Hita-based local wisdom digital comic media on ecosystem materials for fifth grade elementary school students," *Didaktik: Scientific Journal of PGSD FKIP Universitas Mandiri*, vol. 9, no. 2, pp. 5585–5596, 2023.
[10] N. Mekalungi and A. Muhibin, "Development of smartphone-based local wisdom digital comic learning media: Social studies subjects in elementary school," *Pendas: Journal of Basic Education*, vol. 10, no. 1, pp. 231–240, 2025.
[11] I. Irwanto and B. Saputra, "Literature study on the development of the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) in R and D research," *Jurnal PPS-TP*, vol. 14, no. 1, pp. 57–73, 2026, doi: 10.23960/jt.v14i1.2026.1415.
[12] F. I. Ulya, Sumarno, and A. Wijayanti, "Development of video media based on discovery learning for elementary school students," *Jurnal Inovasi Teknologi Pendidikan,* vol. 8, no. 1, pp. 68–83, 2021.
[13] Warda, R. Susanti, and L. R. R. Susanti, "Needs analysis for developing interactive learning multimedia using Canva on fifth-grade elementary school natural feature change material," *Borobudur Educational Review,* vol. 5, no. 1, pp. 195–207, 2025.
[14] Irmawati and S. Hadi, "Development of a PBL-based e-module to improve students' concept understanding on SPLDV material at SMP Negeri 1 Bantur," *Laplace: Journal of Mathematics Education,* vol. 1, no. 1, 2024.
[15] K. Anafi, I. Wiryokusumo, and I. P. Leksono, "Development of ADDIE model learning media using Unity 3D software," *Journal of Education and Development,* vol. 9, no. 4, pp. 433–438, 2021.
[16] T. Salsabila, M. Basri, R. Pranata, Hairida, and H. Kresnadi, "Validity of comic learning media for Science and Social Studies material on the water cycle for 5th grade at SDN 36 Pontianak Kota," *PGSD Journal: Scientific Journal of Elementary School Teacher Education,* vol. 18, no. 2, pp. 147–155, 2025.
[17] C. O. Edhilaningsih and S. Trihantoyo, "Development of digital-based training modules to improve the professional competence of education unit mentors in the Semarang area," *E-Journal of Educational Management Inspiration,* vol. 12, no. 1, pp. 84–95, 2025.
[18] A. Amini and M. I. Damayanti, "Development of digital comics to improve storytelling skills of second-grade elementary school students," *JPGSD,* vol. 9, pp. 2670–2684, 2021.
[19] S. Rahayu and V. D. Wicaksono, "Development of digital comics as an anti-bullying educational medium in elementary schools," *JPGSD,* vol. 11, no. 1, pp. 75–84, 2021.
[20] I. G. R. Sudiawan, N. M. Asril, and N. M. D. Sari, "Development of problem-based learning digital comic media to improve critical thinking skills of fifth-grade students in social science subjects," *Indonesian Journal of Educational Science Research,* vol. 5, no. 2, pp. 1457–1466, 2026.
[21] D. Talia, F. N. Zunaidah, and T. I. Sulistiyowati, "Development of learning media based on Kodig (Digital Comic) on cultural diversity material for fourth-grade students at SDN Mojoroto 4," *Pendas: Scientific Journal of Basic Education*, vol. 10, no. 3, 2025.
[22] M. U. M. Pratiwi, I. G. Margunayasa, and D. A. W. M. Putr, "Bali local wisdom-based digital comic 'Subak' on ecosystem material to improve fifth-grade students' science literacy," *Pendas: Scientific Journal of Basic Education,* vol. 11, no. 1, 2026.
[23] A. Rahma and P. R. D. Kusumawati, "Effectiveness of science comic media on students' science literacy," *Jurnal Basicedu,* vol. 8, no. 4, pp. 3455–3464, 2024.
[24] F. Delima and Arwin, "Development of learning media using Articulate Storyline 3 in fourth-grade elementary school classrooms," *Pendas: Scientific Journal of Basic Education,* vol. 9, no. 2, pp. 4236–4245, 2024.
[25] T. Safitri, C. Dewi, Nofri, and E. Yanto, "Analisis kebutuhan media pembelajaran komik digital berbasis Culturally Responsive Teaching (CRT) pada pembelajaran IPAS kelas IV SD," *Konferensi Ilmiah Dasar,* vol. 6, 2025.
[26] H. Widiani, L. Nur, and E. R. Saputra, "Pengembangan media komik digital berbasis Contextual Teaching Learning pada Proyek Penguatan Profil Pelajar Pancasila," *Jurnal Penelitian Pendidikan,* vol. 25, no.

1, pp. 16–25, 2025.
[27] K. A. Anggarini, I. G. Astawan, and G. A. S. Trisna, "Pengembangan e-comic interaktif terintegrasi pendidikan perubahan iklim untuk literasi lingkungan," *Jurnal Basicedu*, vol. 10, no. 3, pp. 928–939, 2026.
[28] A. H. Primadita, I. S. Suja'i, and S. R. Rindrayani, "Local wisdom-based e-comic to enhance fifth grade elementary students' understanding of regional economic concepts in Tulungagung Regency," *IJE: Interdiciplinary Journal of Education*, vol. 3, no. 3, pp. 318–332, 2025.
[29] D. Nova, H. Budiono, and H. Badri, "Development of digital comic learning media assisted by the Pixton application on local wisdom material in grade V elementary school," *Pendas: Journal of Basic Education Science*, vol. 10, no. 4, 2025.
[30] K. A. Rahman and A. E. Andriani, "Development of digital education comics on style around us to improve IPAS learning outcomes," *Journal of Education Sciences*, vol. 9, no. 4, pp. 2950–2966, 2025.