

Developing an Android-Based Contextual Teaching and Learning Application to Improve the Science Literacy of Grade V Elementary School Students on Food Chain Concepts

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ARTICLE INFO	ABSTRACT
Keywords: Chain Education; Contextual Teaching and Learning (CTL); Science literacy; Application Development; Food Chain	Science literacy is an important competency that needs to be developed in elementary school students. However, based on the results of observations, it shows that students' ability in food chain materials at MI Nurul Hasan Singgahan Ponorogo is still relatively low. This research aims to develop and test the feasibility, practicality, and effectiveness of the Chain Education application, which is an Android-based learning application that applies <i>the Contextual Teaching and Learning (CTL)</i> approach. The research used <i>the Research and Development (R&D)</i> method with the ADDIE model involving 29 students in class V. Data were collected through observation, interviews, expert validation, questionnaires, and tests, then analyzed descriptively using <i>paired sample t-test</i> and N-Gain tests. The results of the study showed that the application obtained a validation score of 93.75% of material experts, 95.40% of media experts, and 95.44% of student responses in the category of very practical. In addition, the average score of students increased from 55.17 to 92.41 with an N-Gain of 0.8789 (high category). These findings show that the CTL-based Chain Education application is feasible, practical, and effective in improving the science literacy of elementary school students.
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INTRODUCTION

Science literacy is one of the essential competencies that students must have in the 21st century. This competence is not only related to mastering scientific concepts, but also the

ability to use scientific knowledge to explain phenomena, make decisions, and solve various problems encountered in daily life. Therefore, the learning of Natural Sciences (IPA) in elementary school is expected to be able to form students who not only understand concepts theoretically, but also are able to relate them to real-life contexts. However, the results of the *Programme for International Student Assessment* (PISA) show that the science literacy ability of Indonesian students is still below the average of OECD member countries.¹ This condition shows that natural science education (IPA) in elementary schools still faces significant challenges, especially in developing scientific thinking skills and connecting scientific concepts with daily life.²

Conceptually, science literacy includes the ability to understand scientific concepts, identify problems based on scientific evidence, evaluate information, and use science knowledge to make responsible decisions.³ Thus, science learning should provide a meaningful learning experience through activities that encourage students to observe, investigate, connect concepts with the surrounding environment, and solve real problems. Learning that is only oriented towards memorizing concepts has not been able to develop science literacy skills optimally.⁴

One of the approaches that is considered to be able to realize meaningful learning is *Contextual Teaching and Learning* (CTL). According to Johnson, CTL is a learning approach that helps students understand the material by connecting academic knowledge and real experience so that learning becomes more meaningful.⁵ This approach is built through seven main components, namely constructivism, inquiry, inquiry, community learning, modeling, reflection, and authentic assessment. Through these components, students are encouraged to actively build knowledge based on the learning experiences gained.

The relationship between CTL and science literacy is very close because both emphasize the ability of students to connect scientific concepts with daily life. The CTL approach provides opportunities for students to observe real phenomena, conduct simple investigations, discuss, and draw conclusions based on the evidence obtained. These

¹ Firdha Yusmar and Rizka Elan Fadilah, "Analisis Literasi Sains Rendah Mahasiswa Indonesia: Hasil Pisa dan Faktor Penyebab," *LENSA (Science Lantern): Jurnal Pendidikan Sains* 13, no. 1 (2023): 11–19.

² Irsan, "Implementasi Literasi IPA dalam Pembelajaran IPA di Sekolah Dasar," *Jurnal Basicedu* 5, no. 6 (2021): 5631–39.

³ Jack Holbrook and Miia Rannikmae, "The Meaning of Scientific Literacy," *International Journal of Environmental & Science Education* 4, no. 3 (2009): 275–288.

⁴ Irsan, "Implementasi Literasi IPA dalam Pembelajaran IPA di Sekolah Dasar," *Jurnal Basicedu* 5, no. 6 (2021): 5631–5639.

⁵ Elaine B. Johnson, *Contextual Teaching & Learning: What It Is and Why It's Here to Stay* (California: Corwin Press, 2002).

activities are in line with the characteristics of science literacy which emphasizes the ability to explain phenomena scientifically, evaluate information, and use evidence in decision-making.⁶ Therefore, the implementation of CTL is seen as able to improve students' science literacy skills more optimally than teacher-centered learning.

In addition to the learning approach, the use of digital media is also an important factor in improving the quality of science learning. Technological developments allow teachers to take advantage of Android-based learning applications that can present material through a combination of text, images, audio, animations, videos, and interactive activities. This kind of media is able to increase learning motivation, student involvement, and help visualize abstract science concepts, including food chain materials.⁷ Thus, the integration of the CTL approach into Android-based applications is expected to be able to provide a more contextual, engaging, and meaningful learning experience.

This problem is also seen at MI Nurul Hasan Singgahan, Ponorogo. Observations reveal that most fifth-graders struggle to understand the concept of food chains, especially in explaining the relationship between living organisms and the flow of energy in an ecosystem. Interviews with teachers show that teaching is still dominated by the use of textbooks and lecture methods, while the use of interactive digital media is still limited. As a result, students tend to be passive and lack the ability to relate the material to their own real-life experiences.

Previous research has shown that digital learning media can improve the quality of science education. A study by Syahmi et al. (2022) shows that smartphone-based digital comics can improve the motivation and conceptual understanding of elementary school students.⁸ Yurnasari (2021) found that Pop-Up Book media is effective in fostering interest in learning and understanding abstract material.⁹ Furthermore, Putri and Kuswanti (2025) proved that flipbooks based on Contextual Teaching and Learning (CTL) significantly improve students' science literacy skills. These findings show that the use of digital media integrated with contextual approaches has the potential to improve students' conceptual

⁶ Uus Toharudin dkk., *Literasi Sains: Pendekatan Pembelajaran Kontemporer* (Depok: Rajawali Press, 2023).

⁷ Richard E. Mayer, *Multimedia Learning*, 2nd ed. (New York: Cambridge University Press, 2009).

⁸ Favian Avila Syahmi et al., "Pengembangan Media Pembelajaran Komik Digital Berbasis Smartphone untuk Siswa Sekolah Dasar," *Jurnal Studi Teknologi Pendidikan* 5, no. 1 (2022): 83.

⁹ Heli Yurnasari, "Pengembangan Media Pembelajaran Bahasa Indonesia Berupa Buku Bergambar Pop-up Materi Dongeng untuk Siswa Kelas 3 SDN 60 Seluma" (Skripsi, IAIN BENGKULU, 2021), 15.

understanding and science literacy.¹⁰

However, research that integrates the CTL approach into interactive digital applications, especially regarding food chain materials for Madrasah Ibtidaiyah students, is still limited. Most previous research has focused on the development of digital comics, flipbooks, or interactive books, while the development of Android-based learning apps specifically designed to improve science literacy through the context of everyday life is still rare.¹¹ This gap provides the basis for the novelty of this research: the development of an Android-based "Chain Education" application using the CTL approach on food chain materials to improve the scientific literacy of Madrasah Ibtidaiyah students.

Unlike previous research that only developed digital media or CTL-based flipbooks, the Chain Education application integrates the entire CTL syntax into interactive learning features such as simulations, educational games, automatic evaluations, and the context of the ecosystem around students so that students not only learn concepts but also build science literacy skills contextually.

Based on the description above, the research problem is how to develop a "Chain Education" application based on the Contextual Teaching and Learning (CTL) approach that is feasible, practical, and effective in improving students' scientific literacy of food chain materials. This research aims to develop a CTL-based Chain Education application, determine its practicality, and analyze its effectiveness in improving the scientific literacy of fifth-grade students at MI Nurul Hasan Singgahan, Ponorogo.

RESEARCH METHODS

This research uses the Research and Development (R&D) method with the ADDIE model which includes five stages, namely *analysis*, *design*, *development*, *implementation*, and *evaluation*.¹² The ADDIE model was chosen because it provides a systematic procedure in developing learning products ranging from needs analysis to product evaluation. In this study, the ADDIE model was applied to develop the Chain Education application, which is an Android-based learning application that integrates *the Contextual Teaching and Learning*

¹⁰ Silviana Kharisma Putri and Nur Kuswanti, "Pengembangan Flipbook Berdasarkan Materi Sistem Ekskresi Manusia Pengajaran dan Pembelajaran Kontekstual (CTL) untuk Melatih Keterampilan Literasi Sains untuk Siswa Kelas XI," *Jurnal Ilmiah Pendidikan Biologi (BioEdu)* 14, no. 1 (2025): 90.

¹¹ Siti Ehda Suhailah and Hasanuddin, "Penggunaan E-Modul Berdasarkan Pendekatan Pengajaran dan Pembelajaran Kontekstual (CTL): Analisis Bibliometrik," *Jurnal Arjuna: Publikasi Pendidikan, Bahasa dan Matematika* 3, no. 3 (2025): 92.

¹² Yudi Hari Rayanto and Sugianti, *Penelitian Pengembangan Model ADDIE dan R2D2: Teori dan Praktek* (Pasuruan: Academic & Research Institute, 2020), 45.

(CTL) approach on food chain materials to improve the science literacy of elementary school students.



Image 1. Model ADDIE

The analysis stage is carried out through observation, interviews, and documentation studies to identify learning needs. The design stage includes application design, material compilation, storyboarding, and research instrument development. In the development stage, the Chain Education application is developed and validated by material and media experts. The implementation stage was carried out through field trials with fifth grade students. Furthermore, the evaluation stage is carried out to assess the feasibility, practicality, and effectiveness of the application.

This research was carried out at MI Nurul Hasan Singgahan, Ponorogo, in the 2025/2026 school year. The research subjects consisted of 29 students in class V who were selected using *the total sampling* technique, namely all members of the population were used as research samples because the population was relatively small and all students were target users of the developed product. Given that the number of research subjects was only 29 students, the results of the study had limitations in terms of generalization, so their application to a wider population needed to be done carefully.

This research has obtained permission from the head of the madrasah and MI class V teacher Nurul Hasan Singgahan before the implementation of the research. All data obtained is used only for academic purposes, is kept confidential, and does not include the personal identity of students in research reports.

The research instruments include observation sheets, interview guidelines, validation sheets for material experts and media experts, student response questionnaires, and science literacy tests. The preparation of the instrument began by determining indicators based on

research objectives, science literacy indicators, and learning outcomes in food chain materials. Furthermore, the instrument is developed into a grid and instrument item before the validation process is carried out by experts.

The validity of the instrument is carried out through expert judgment involving material experts and media experts to assess the suitability of the content, clarity of language, presentation, and feasibility of the instruments and products developed. Input from the validators is used as a basis for improving applications and instruments before testing them to students. In addition, the student response questionnaire was compiled using the Likert scale and reviewed so that each statement was easy to understand and in accordance with the characteristics of elementary school students.

Research data were collected using observation, interviews, documentation, questionnaires, and tests. The instruments used in this study are presented in Table 1.

Table 1. Research Instruments

R Value	Interpretation
0.81-1.00	Very high
0.61-0.80	Height
0.41-0.60	Medium
0.21-0.40	Low
0.00-0.20	Very low

Qualitative data were analyzed descriptively based on the results of observations, interviews, and validator feedback. Quantitative data were analyzed using descriptive and inferential statistics. The feasibility and practicality of the application were calculated using a percentage score, while the effectiveness of the application was analyzed using the N-Gain test and the paired sample t-test at a significance level of 0.05. The criteria for the interpretation of N-Gain are presented in Table 2.

Table 2. N-Gain Score Criteria

N-Gain Score	Categories
≥ 0.70	Height
0,30 – 0,69	Medium
< 0.30	Low

RESULTS AND DISCUSSION

Results

This section presents the results of research on the development of Chain Education applications based on the Contextual Teaching and Learning (CTL) approach on food chain materials to improve the science literacy of elementary school students. The discussion in this section includes the description of the product developed, the results of the product feasibility test based on the validation of experts, and the results of the product effectiveness test in improving students' science literacy.

Product Description

The product developed in this study is in the form of an Android-based learning application called Chain Education which is designed using *the Contextual Teaching and Learning* (CTL) approach to food chain materials. The app was developed to help elementary school grade V students understand the concept of the food chain through interactive, contextual, and easy-to-operate learning. Application development is carried out using the ADDIE model, resulting in learning media that combines materials, interactive activities, and evaluations in one application.



Image 2. Opening Page

Figure 2. shows the splash screen of the Chain Education application which displays the identity of the application along with an illustration of the ecosystem as a representation of the food chain material. This initial appearance is designed to give an attractive impression while preparing students before entering the learning process.



Image 3. Main Menu

On the main menu, the application provides several menus that students can access, namely introduction, learning objectives, materials, educational games, evaluations, and developer profiles. The menu layout is made simple with easily recognizable icons that make it easier for students to select the desired features without experiencing difficulties in navigation.



Image 4. Materials Menu

Furthermore, the material menu presents the concept of the food chain systematically using a combination of text and illustrations. The presentation of the material is prepared based on the CTL approach by connecting the concept of the food chain to the phenomena encountered by students in their daily lives so that learning becomes more meaningful and supports the improvement of science literacy.



Image 5. Educational Games

As a means of training, the app provides educational games that use a *drag and drop* mechanism to correctly sequence the food chain. This activity provides students with the opportunity to learn while playing so that they can increase engagement, motivation, and understanding of concepts during the learning process.



Image 6. Evaluation Menu

At the end of the screen, the application provides an evaluation menu in the form of multiple-choice questions that are used to measure students' level of understanding after learning the material. The system provides feedback directly so that students can know the learning outcomes. With the integration of materials, educational games, and evaluations in one application, Chain Education is able to support science learning that is more interactive, contextual, and oriented towards improving the science literacy of elementary school students.

Product Eligibility

In the feasibility of this product, there are validation assessment results obtained based on material experts and media experts. The following are the validation results based on expert assessments listed in the following table.

Table 3. Results of the Expert Assessment

No	Aspects Assessed	Percentage (%)	Percentage
1	Material Feasibility	93,75%,	Highly Valid
2	Media Eligibility	95,4%,	Highly Worth It
Average		94,57%	Highly Worth It

The validation results show that the Chain Education application based on *the Contextual Teaching and Learning* (CTL) approach is in the category of being very feasible for use in learning. The material aspect received a very good assessment because it was in accordance with the learning achievements of food chain material, had the accuracy of concepts, used easy-to-understand language, and supported the improvement of students' science literacy. Meanwhile, the media aspect is considered to have an attractive appearance, easy-to-use navigation, interactive presentation, and able to support the learning process effectively. Thus, the Chain Education application meets the criteria as a learning medium that is suitable to be applied in science learning in elementary schools.

Product Effectiveness

The effectiveness of the Chain Education application was analyzed through the results of students' pretest and posttest, then strengthened by *the paired sample t-test* and the N-Gain test. The results of the calculation are shown in the following table:

Table 4. Paired Sample Test Calculation Results

		Paired SamplesTest							
		Paired Differences					t	df	Sig.
			Std.	Std.	95% Confidence				(2-
			Deviation	Error	Interval of the				tailed)
		Red		Mean	Lower	Upper			
Pair 1	Pretest-	-	12.78854	2.37477	-	-	-	28	.000
	Posttest	37.24138			42.10588	32.37688	15.682		

Table 5. N-Gain Calculation Results

Descriptive Statistics					
	N	Minimum	Maximum	Red	Std. Deviation
N-gain_Score	29	.60	1.00	.8789	.14072
N-gain_Persen	29	60.00	100.00	87.8859	14.07151
Valid N (listwise)	29				

Based on the two tables above, the results of the analysis show that the average score of students has increased. The results of the *paired sample t-test* obtained a significance value of 0.000 (< 0.05), which indicates that there is a significant difference between learning outcomes before and after using the application. Thus, the use of Chain Education applications based on the *Contextual Teaching and Learning* (CTL) approach has a significant influence on improving students' science literacy.

In addition, the results of the N-Gain test obtained an average score of 0.8789 or 87.89%, which is included in the high category. The results show that the improvement of students' science literacy skills is at a high level after using the Chain Education application. These findings indicate that the integration of the CTL approach with Android-based learning media can help students understand the concept of the food chain more meaningfully through the presentation of contextual materials, interactive activities, educational games, and evaluations that provide direct feedback. Therefore, the Chain Education application was declared effective as a learning medium to improve the science literacy of elementary school students on food chain materials.

Discussion

CTL Development and Approach

The development of the *Chain Education* application in this study refers to the ADDIE model which consists of five stages, namely *analysis*, *design*, *development*, *implementation*, and *evaluation*. The ADDIE model was chosen because it provides a systematic procedure in developing learning media, ranging from needs analysis to product evaluation.¹³ Through these stages, the development process can be carried out in a structured manner so as to produce learning media that is in accordance with the characteristics of students and learning objectives. The results of the study show that the *Chain Education* application has been successfully developed as an Android-based learning media that integrates the *Contextual Teaching and Learning* (CTL) approach to food chain materials so that it is able to create a more interactive, contextual, and meaningful learning experience for elementary school students.¹⁴

At the analysis stage, it was found that the science learning process at MI Nurul Hasan Singgahan is still dominated by lecture methods and the use of textbooks, while the use of

¹³ Robert Maribe Branch, *Instructional Design: The ADDIE Approach* (New York: Springer, 2009), 20.

¹⁴ Yudi Hari Rayanto and Sugianti, *Penelitian Pengembangan Model ADDIE dan R2D2: Teori dan Praktek* (Pasuruan: Academic & Research Institute, 2020), 45–53.

digital learning media is not optimal. This condition causes students to experience difficulties in understanding the relationship between organisms in the food chain material and are not able to relate the concepts learned to phenomena in the surrounding environment. These findings are in line with the opinion of Holbrook and Rannikmae who stated that science literacy emphasizes not only mastery of concepts, but also the ability to use scientific knowledge to explain the phenomena of everyday life.¹⁵ Therefore, *the Chain Education application* was developed as an alternative learning media that is able to connect scientific concepts with real experiences through the application of the CTL approach.

The design and development stage produces an Android-based learning application that contains an opening page, main menu, materials, educational games, and evaluations. The presentation of material is supported by texts, pictures, illustrations, and interactive activities so that students get a more concrete learning experience. The educational game is designed using a *drag and drop* mechanism to correctly sequence the food chain, while the evaluation menu provides direct feedback on students' answers. These characteristics are in accordance with the theory of cognitive development which explains that elementary school students understand concepts more easily if they are presented through concrete, visual, and engaging learning experiences.¹⁶

The development of this application also implements *the principles of Contextual Teaching and Learning* (CTL). According to Johnson, CTL is a learning approach that helps students connect academic materials with real situations so that the knowledge gained becomes more meaningful.¹⁷ These principles are manifested in the application through the presentation of examples of ecosystems close to students' lives, simple investigation activities, educational games, and evaluations that encourage students to build their own knowledge. Thus, students not only memorize the sequence of the food chain, but also understand the relationships between living things based on the phenomena they encounter in the surrounding environment.

In addition to applying the CTL approach, *the Chain Education* application also utilizes the principle of multimedia learning. Mayer explained that the combination of text, images, audio, animation, and interaction can improve students' understanding of abstract concepts

¹⁵ Jack Holbrook and Miia Rannikmae, "The Meaning of Scientific Literacy," *International Journal of Environmental & Science Education* 4, no. 3 (2009): 275–288.

¹⁶ Robert E. Slavin, *Educational Psychology: Theory and Practice*, 12th ed. (New York: Pearson, 2018), 40–56.

¹⁷ Elaine B. Johnson, *Contextual Teaching and Learning: What It Is and Why It's Here to Stay* (California: Corwin Press, 2002), 24–39.

compared to the use of one form of media alone.¹⁸ Therefore, the presentation of materials in the application is designed by combining various multimedia elements so that the concept of the food chain can be understood more easily. The integration of these components makes learning more engaging, increases student attention, and encourages active engagement during the learning process.

The findings of this study are in line with the research of Syahmi et al. which shows that smartphone-based digital learning media is able to increase learning motivation and conceptual understanding of elementary school students.¹⁹ In addition, Putri and Kuwanti's research also proves that CTL-based learning media is effective in improving students' science literacy skills.²⁰ However, this research has a novelty because it develops an Android application that integrates the entire CTL syntax into one learning medium through the presentation of materials, educational games, and automatic evaluation of food chain materials. Thus, *the Chain Education* application not only functions as a medium for delivering material, but also as a means to support the development of students' science literacy through active, contextual, and meaningful learning experiences.

Product Eligibility Results

The feasibility of *the Chain Education application* is evaluated through a validation process carried out by material experts and media experts before the product is implemented to students. The validation stage aims to ensure that the developed application meets the standards of content, presentation, language, and technical aspects as a learning medium. The validation results showed that the application obtained a feasibility percentage of **93.75%** from material experts and 95.40% from media experts with an average of 94.57%, so it is included in the category of very feasible to be used in science learning in elementary schools. These results show that *the Chain Education* application has met the criteria as a valid learning medium both from the material and media aspects.²¹

¹⁸ Richard E. Mayer, *Multimedia Learning*, 2nd ed. (New York: Cambridge University Press, 2009), 223–266.

¹⁹ Favian Avila Syahmi et al., "Pengembangan Media Pembelajaran Komik Digital Berbasis Smartphone untuk Siswa Sekolah Dasar," *Jurnal Studi Teknologi Pendidikan* 5, no. 1 (2022): 80–92.

²⁰ Silviana Kharisma Putri and Nur Kuswanti, "Pengembangan Flipbook Berbasis Materi Sistem Ekskresi Manusia Pengajaran dan Pembelajaran Kontekstual (CTL) untuk Melatih Keterampilan Literasi IPA Siswa Kelas XI," *Majalah Ilmiah Pendidikan Biologi (BioEdu)* 14, no. 1 (2025): 85–98.

²¹ Yudi Hari Rayanto and Sugianti, *ADDIE dan R2D2 Model Development Research: Teori dan Praktek* (Pasuruan: Academic & Research Institute, 2020), 85–88.

The results of the material expert's assessment show that the food chain material presented in the application is in accordance with learning outcomes, has conceptual accuracy, is systematically arranged, and uses language that is easy for elementary school students to understand. In addition, the presentation of the material has accommodated science literacy indicators through the presentation of phenomena that are close to the lives of students so that they are able to help students connect scientific concepts with the surrounding environment. The findings show that the material contained in the application is not only oriented to mastering concepts, but also supports the development of students' scientific thinking skills.²²

Meanwhile, the results of media expert validation showed that the app has an attractive interface, easy-to-use navigation, appropriate color composition, and a mix of text, images, and illustrations that can enhance the appeal of learning. In addition to the visual aspect, the application is also considered to have a good level of interactivity through the provision of educational games, automatic evaluations, and direct feedback on student learning outcomes. This condition shows that *the Chain Education* application has met the principles of effective digital learning media, which are easy to use (*user friendly*), attractive, interactive, and able to support the active involvement of students during the learning process.²³

The results of the validation are in line with Arsyad's opinion that a good learning media must be able to facilitate the delivery of information, increase students' attention, and provide a more effective learning experience through attractive and easy-to-understand visuals.²⁴ In addition, Mayer explained that the use of multimedia that combines text, images, audio, and animation is able to improve understanding of concepts because students obtain information through more than one cognitive channel.²⁵ Thus, the presentation of materials and interactive features in *the Chain Education* application is in accordance with the principles of modern learning media development.

The findings of this study are also supported by Handayani and Rahayu's research which states that Android-based learning media developed using iSpring has a very high level of validity because it is able to present material interactively and is easy to operate by

²² Uus Toharudin et al., *Literasi Sains: Pendekatan Pembelajaran Kontemporer* (Depok: Rajawali Pers, 2023), 27–36.

²³ Army Trilidia De Vega, *Pengembangan Aplikasi Media Pembelajaran Interaktif Berbasis Android* (Batam: CV Batam Publisher, 2022), 45–60.

²⁴ Azhar Arsyad, *Media Pembelajaran* (Jakarta: Rajawali Pers, 2019), 21–35.

²⁵ Richard E. Mayer, *Multimedia Learning*, 2nd ed. (New York: Cambridge University Press, 2009), 223–266.

students.²⁶ Research by Muttaqin et al. also shows that Android-based science learning media is considered very suitable for use because it is able to improve the quality of learning through attractive visual displays and simple navigation.²⁷ The results of the study reinforce that Android-based learning media has great potential to support the science learning process in elementary schools.

Overall, the validation results show that *the Chain Education application* has met the eligibility criteria both in terms of material and media aspects. The suitability of the material with learning outcomes, the accuracy of the concept, the ease of navigation, the attractive display, and the presentation of interactive activities are the main factors that support the high level of feasibility of the application. Therefore, *the Chain Education application* is suitable for use as an Android-based learning media that is able to support the implementation of *the Contextual Teaching and Learning (CTL)* approach while improving the quality of science learning in food chain materials in elementary schools.

Effectiveness in Improving Science Literacy

The effectiveness of *the Chain Education application* in this study was analyzed through a comparison of the results of *the pretest* and *posttest* of science literacy of grade V students of MI Nurul Hasan Singgahan Ponorogo. The analysis aims to determine changes in students' science literacy skills before and after using applications in science learning on food chain materials. The results showed that the average score of students increased from 55.17 during *the pretest* to 92.41 during *the posttest*. In addition, the results of *the paired sample t-test* obtained a significance value of 0.000 (<0.05), indicating a significant difference between learning outcomes before and after using the application. The N-Gain value of 0.8789 which is in the high category further strengthens that *the Chain Education application* is effective in improving students' science literacy.²⁸

The improvement in learning outcomes shows that the use of *the Chain Education application* is able to help students understand the concept of the food chain more

²⁶ Denih Handayani and Diar Veni Rahayu, "Pengembangan Media Pembelajaran Interaktif Berbasis Android Menggunakan iSpring dan APK Builder untuk Materi Proyeksi Vektor Pembelajaran Matematika Kelas X *Matematika*," *Mathline: Jurnal Pendidikan Matematika dan Matematika* 5, no. 1 (2020): 1–15.

²⁷ Hendra Pratisnojati Shoheh Muttaqin and N. K. Suarni, "Pengembangan Media Pembelajaran Interaktif Berbasis Android Menggunakan iSpring dan APK Builder untuk Materi Proyeksi Vektor Pembelajaran Matematika Kelas X *Matematika*," *Mathline: Jurnal Pendidikan Matematika dan Matematika* 511, no. 1 (2021): 1–15.

²⁸ Richard R. Hake, "Interactive-Engagement versus Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses," *American Journal of Physics* 66, no. 1 (1998): 64–74.

comprehensively than previous learning. This is inseparable from the characteristics of the application that integrates materials, illustrations, educational games, and evaluation in one learning medium. The presentation of the material contextually provides an opportunity for students to relate the concept of the food chain to the phenomena they encounter in the surrounding environment, so that learning is not only oriented to memorizing concepts, but also to the ability to understand the relationships between ecosystem components based on scientific evidence. Thus, the increase in students' science literacy is not only reflected in the increase in test scores, but also in the ability of students to explain science phenomena based on real-life contexts.²⁹

The results of this study are in line with *the Contextual Teaching and Learning* (CTL) theory put forward by Johnson, namely that learning will become more meaningful if students build their own knowledge through real experience and relate the material to daily life.³⁰ In the *Chain Education application*, this principle is realized through the presentation of examples of ecosystems that are close to the student environment, educational game activities, and evaluations that provide direct feedback. Through these activities, students not only receive information from teachers, but actively build their understanding of the concept of the food chain so that the learning process becomes more meaningful.

From the perspective of science literacy, the results of this study also support the opinion of Holbrook and Rannikmae who stated that science literacy is a person's ability to use scientific knowledge to explain phenomena, evaluate information, and make decisions based on scientific evidence.³¹ During the learning process using the *Chain Education* application, students not only learn the sequence of the food chain, but also analyze the relationships between organisms, understand the flow of energy in the ecosystem, and connect the material to the environmental conditions around them. These activities show that the learning developed has accommodated science literacy indicators which are the main goals of science learning in elementary schools.

The success of the *Chain Education application* is also supported by the application of multimedia learning principles. Mayer explained that the presentation of material through a combination of text, images, audio, animation, and interactive activities is able to improve

²⁹ Uus Toharudin et al., *Literasi Sains: Pendekatan Pembelajaran Kontemporer* (Depok: Rajawali Pers, 2023), 21–38.

³⁰ Elaine B. Johnson, *Contextual Teaching and Learning: What It Is and Why It's Here to Stay* (California: Corwin Press, 2002), 24–39.

³¹ Jack Holbrook and Miia Rannikmae, "The Meaning of Scientific Literacy," *International Journal of Environmental & Science Education* 4, no. 3 (2009): 275–288.

the process of understanding because information is received through more than one cognitive channel.³² In the developed application, food chain materials are visualized through illustrations, drawings, educational games, and interactive evaluations so that concepts that were originally abstract become more concrete and easy to understand by students. These characteristics provide a more engaging learning experience, increase student attention, and encourage active involvement during the learning process.

The findings of this study are consistent with the research of Syahmi et al. which shows that smartphone-based digital learning media is able to increase the learning motivation and conceptual understanding of elementary school students.³³ Putri and Kuwanti's research also reported that *Contextual Teaching and Learning* (CTL)-based learning media is effective in improving students' science literacy skills through learning that connects concepts with real situations.³⁴ In addition, research by Anggraeni and Oktiningrum shows that Android-based interactive learning media is able to improve students' abilities because it provides a more interesting and easy-to-operate learning experience.³⁵ The results of this study reinforce these findings while showing that the integration of the CTL approach into Android applications makes a positive contribution to improving the science literacy of elementary school students.

However, this study has different characteristics compared to previous studies. Most previous research has developed digital media in the form of *flipbooks*, digital comics, or e-modules that focus on presenting learning materials. This research offers novelty through the development of an Android application that integrates all learning components in one medium, ranging from the delivery of materials, educational games, automatic evaluations, to the application of the CTL approach to food chain materials. The integration allows students to obtain a more complete, interactive, and contextual learning experience so that it not only improves learning outcomes, but also develops science literacy skills more optimally.

³² Richard E. Mayer, *Multimedia Learning*, 2nd ed. (New York: Cambridge University Press, 2009), 223–266.

³³ Favian Avila Syahmi et al., "Pengembangan Media Pembelajaran Komik Digital Berbasis Smartphone untuk Siswa Sekolah Dasar," *Jurnal Studi Teknologi Pendidikan* 5, no. 1 (2022): 80–92.

³⁴ Silviana Kharisma Putri and Nur Kuswanti, "Pengembangan *Flipbook* Berbasis Materi Sistem Ekskresi Manusia Pengajaran dan Pembelajaran Kontekstual (CTL) untuk Melatih Keterampilan Literasi IPA Siswa Kelas XI," *Majalah Ilmiah Pendidikan Biologi (BioEdu)* 14, no. 1 (2025): 85–98.

³⁵ Alfina Dewi Anggraeni and Wuli Oktiningrum, "Pengembangan Media Pembelajaran Interaktif PETRANUM Berbasis Android untuk Meningkatkan Kemampuan Berhitung Siswa SD," *Diniyah: Jurnal Pendidikan Dasar* (2024): 1–15.

Theoretically, this research contributes to the development of technology-based learning media in science learning in elementary schools. The findings of the study prove that the application of the ADDIE model is able to produce valid, practical, and effective learning media, while the integration of the CTL approach in the Android application is able to improve the quality of student-centered learning. From a practical perspective, *the Chain Education application* can be an alternative learning media for teachers in delivering food chain materials in a more interesting, interactive, and contextual way. Therefore, this application has the potential to become one of the digital learning innovations that can support the implementation of 21st century learning while improving the science literacy skills of elementary school students.

CONCLUSION

Based on the results of the research, this study succeeded in developing a *Chain Education* application based on *the Contextual Teaching and Learning* (CTL) approach on food chain materials to improve the science literacy of elementary school students. Development is carried out using the ADDIE model which includes the stages of analysis, design, development, implementation, and evaluation. The validation results showed that the application obtained a very feasible category with a percentage of 93.75% from material experts and 95.40% from media experts, thus meeting the criteria as a valid learning medium to be used in science learning. In addition, the implementation results show that the app has received a positive response from students and is easy to use in the learning process.

In terms of effectiveness, *the Chain Education application* has been proven to be able to significantly improve students' science literacy. This is shown by the increase in the average score of students from 55.17 during *the pretest* to 92.41 during *the posttest*, the significance value of *the paired sample t-test* of 0.000 (<0.05), and the N-Gain value of 0.8789 which is included in the high category. The findings show that the integration of the CTL approach with Android-based learning media is able to help students understand the concept of the food chain in a more contextual, interactive, and meaningful way.

This research contributes to the development of technology-based science learning media by presenting an Android application that integrates materials, educational games, automatic evaluation, and CTL principles in one learning medium. This contribution enriches the study of the development of digital media to improve the science literacy of elementary school students while providing empirical evidence that contextual learning

supported by technology can improve the quality of science learning.

However, this study has some limitations. The implementation of the application was carried out only in one school with a limited number of samples and focused on food chain materials in grade V of elementary school. Therefore, the results of this study cannot be generalized widely to all levels, school characteristics, and other science materials.

Based on these limitations, further research is recommended to test the effectiveness of applications in different schools, larger sample sizes, diverse grade levels, and other science materials to obtain a more comprehensive picture of the influence of applications on students' science literacy. Subsequent research may also develop more innovative features, such as *augmented reality* integration, adaptive learning, or student learning progress tracking systems.

For education practitioners, teachers can use the *Chain Education* application as an alternative learning media to support more interactive and student-centered science learning. Schools can also encourage the use of Android-based learning media as part of digital learning transformation. In addition, the results of this study have implications for curriculum development, especially in supporting the implementation of learning oriented towards strengthening science literacy, the use of educational technology, and the development of 21st century competencies in elementary school students.

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