Jurnal Teknologi Pendidikan, April 2024, 26 (1), 63-83
DOI: http://dx.doi.org/10.21009/JTP2001.6
p-ISSN: 1411-2744 e-ISSN: 2620-3081
Accredited by Directorate General of Strengthening for Research and Development
Available online at http://journal.unj.ac.id/unj/index.php/jtp

QR Code-Based Digital Media for Scientific Literacy Skills Enhancement of Elementary School Students

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Received : January 30, 2024
Revised : March 25, 2024
Accepted : March 26, 2024

Abstract

QR Code-based learning encourages teachers to be more creative in designing lessons and students to become more active in the learning process. The problems that are present are the low literacy skills of students in the field of science education, the lack of ability in the field of digital-based technology for science literacy learning, describing alternative solutions to improve science literacy in elementary school students. The development of learning materials in the form of QR Code-based E-Modules aims to enhance higher-order thinking skills in thematic learning. This research aims to develop, validate, and assess effectiveness development of QR Code-Based digital media to enhance scientific literacy skills in the teaching of natural sciences. The research design follows the Research and Development (R&D) method, specifically the Richey and Klein method, consisting of three stages: Planning, Production, and Evaluation. Validation results from media experts show a percentage of 91.57%, language experts 84.38%, and content experts 96.13%. Thus, the developed product is considered highly feasible and ready for testing. The next stage involves one-to-one testing, small group testing, and field testing. One-toone testing scores were 90.28%, small group testing was 93.33%, and field testing was 85.74%. To verify the accuracy of the data, a paired sample t-test using SPSS is conducted, resulting in significance = 0.000 < 0.05. Therefore, it can be concluded that implementing QR Code-based digital media in science education has a significant positive effect, making it highly feasible and effective for use in fourth-grade science classrooms. Thus with this research students' abilities in implementing scientific literacy in everyday life can be improved to achieve better learning outcomes.

Keywords: Scientific Literacy, Natural Sciences, QR Code

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How to Cite: Kartika Sari, P., & Nabilla Qonita, D. (2024). QR Code-Based Digital Media for Scientific Literacy Skills Enhancement of Elementary School Students. *JTP - Jurnal Teknologi Pendidikan*, *26*(1), 63-83. https://doi.org/10.21009/jtp.v26i1.43285

INTRODUCTION

21st-century education is greatly affected by technological advancements, particularly with the emergence of the 4th Industrial Revolution. 21st-century education aims to prepare students with the skills, knowledge, and understanding necessary for success in a constantly changing and evolving world. 21st-century education emphasizes a shift in mindset that encourages learners to acquire skills relevant to the needs of the time. One of the crucial skills highlighted in 21stcentury education is scientific literacy. (Awwalina et al.,2022). In the 21st century, student-centered learning has become the primary focus. Students tend to learn better when

actively engaged in the learning process rather than merely receiving oral explanations from teachers. (Salsabila Adi et al.,2023).

However, the inclination to use technology more for entertainment, social media, and recreational activities rather than for reading information that can enhance literacy and knowledge often poses a challenge. Low literacy interest and literacy rates in Indonesia are serious issues impacting various aspects, especially in the learning process. Low literacy can be a significant barrier to acquiring knowledge, understanding information, and developing skills required in various fields. The lack of reading interest and low literacy affects not only formal education but also everyday life in society. In the learning context, low reading abilities can hinder the comprehension of lesson materials, diminish critical thinking skills, and reduce opportunities to access crucial information.(Gufran & Mataya, 2020)

21st-century learning emphasizes developing various core skills, and scientific literacy is a strong foundation for achieving these skills. Characteristics of 21st-century learning indicate the implementation of several core competencies, including critical thinking, problem-solving, creativity, communication, and collaboration, which are essential in today's continually evolving environment. Scientific literacy is not only about understanding scientific concepts but also about training in logical thinking, analyzing information, and making decisions based on available evidence. (Kemendikbud, 2023). In this case according to (Gunawan Santoso et al.,2023). The development of information and communication technology is two important phenomena that have implications for the 21st century learning paradigm, to increase collaboration, interaction, and participation in their learning activities, and support creating a constructive learning environment.

Data from the Program for International Student Assessment (PISA) reveals that Indonesian students' average score for scientific literacy skills is below the global average, standing at 396 in 2018, while the global average score is 500 (OECD, 2019). The low level of scientific literacy skills raises concern as scientific knowledge plays a crucial role in understanding the modern world driven by scientific and technological advancements. Low scientific literacy skills can hinder students' ability to comprehend, analyze, and evaluate scientific information, which is vital for intelligent decision-making and participation in an increasingly globally connected society. (OECD, 2019). In this case according to Sholehuddin (2018) Therefore, humans are the only creatures that can develop both qualitatively and quantitatively. In both elements, there are potentials that can be developed, and that, is a human strategy to maintain the existence of humanity in this world. He also has a culture that will continue to develop to fill the spaces of his life. That way, humans can be called cultured creatures and develop along with the discovery of various innovations for the continuation of a better life.

Achievements in scientific literacy in schools are affected by various factors. The school context, including teaching processes, school resources, and students' backgrounds, can significantly affect the learning outcomes of natural science (Ding, 2022). Scientific literacy also affects an individual's character, fostering a more caring or environmentally sensitive attitude (Carl et al., 2016; Lee et al., 2015).

One of the causes of the low level of scientific literacy among students is the use of approaches, methods, strategies, and learning models that are often inappropriate and tend to be teacher-centered rather than oriented toward character formation (Boulton, 2017; Hagermoser Sanetti & Collier-Meek, 2019). Guiding students to engage in learning actively is a student-centered approach that applies the principles of Constructivist Learning Theory (Jufrida et al., 2019).

Examining data from PISA and TIMSS, it is evident that the scientific literacy skills of Indonesian students remain significantly low (Suparya et al., 2022). From this data, we can correlate this with learning that requires literacy skills, such as science education in primary schools (Suparya et al., 2022). Educators play a crucial role in developing scientific literacy skills by enhancing knowledge in investigating scientific materials, improving oral and written vocabulary for understanding and communicating science, and strengthening the connection between science, technology, and society (Pertiwi, Atanti, & Ismawati (2018). The purpose of this article is to address the low literacy skills of students in the field of science education, the lack of ability in the field of digital-based technology for science literacy learning, and to present alternative solutions to improve science literacy in elementary school students. Learning materials in the form of QR Code-based E-Modules aim to improve higher order thinking skills in thematic learning.

The reality at school based on the researcher's observation shows that during learning, students receive more information from the teacher, especially in subjects such as science, most of which are abstract. Traditional tools such as pictures, blackboards, and manuals are still used in the learning process, this shows the low interest of students in learning science subjects. This is evident as some students engage in conversations with classmates or even play games during lessons. Some students remain silent, merely sitting and listening. Communication between teachers and students during lessons is predominantly one-way. At best, students attempt to answer questions posed by the teacher during lessons. However, based on previous diagnostic tests, it is evident that almost all students do not enjoy learning science Students struggle to comprehend the material due to its abstract nature, requiring real-life experiences to facilitate understanding. The predominant learning style among fourth-grade students at MI Muhammadiyah 01 is kinesthetic.

Thus, monotonous learning with limited student activities leads to boredom and disinterest in learning among students (Adesola et al., 2019). This results in a lack of understanding of concepts, preventing the application of learned concepts or theories in real-life situations. Additionally, students are not accustomed to learning by encountering various events or phenomena in their daily lives, contributing to a lack of scientific literacy among many students. Multimedia presents a potential solution that could be used to create a more interactive learning environment, connecting the material to everyday phenomena or cases to enhance students' scientific literacy.

Media is one of the most crucial elements that make learning more enjoyable and meaningful for students. One form of learning media is multimedia, which combines audio, visual, and graphic elements. Multimedia presentations can encourage students to actively participate in learning by mentally representing the material through words and images and establishing connections between visual

and verbal presentations (Jabbour, 2012). Utilizing multimedia that integrates graphics, sound, and text assists students in learning educational concepts in a more meaningful and enjoyable manner (Rosandi et al., 2016). In line with Santi & Al Bahij (2017: 149) who argue that media is something that is channeling messages and can stimulate the thoughts, feelings and desires of students so that it can encourage the learning process in him.

The quality of education can be enhanced by utilizing digital learning technology (Kristiawati et al., 2023) (Soboleva et al., 2022). Digital learning is a system that facilitates students' learning more broadly and diversely (Laksana, 2020; Saputra & Gunawan, 2021).

Digital learning involves the use of online or digital learning systems. It begins with thorough planning (Sumarni, Darhim, & Fatimah, 2019), and this plan should serve as a reference when delivering learning materials to students. The advantage of digital learning is that it provides an enjoyable medium, capturing students' interest in digital programs (Allen, 2016; Sitopu et al., 2022).

Research on various learning environments utilizing QR code-based learning has shown positive student responses. Two studies conducted by (Awwalina & Indana (2022) and Pratiwi & Indana (2022) explain that students react positively to biology learning using QR code-based e-modules, contributing to improved student learning outcomes. Other research conducted by Mustakim et al. (2013) and Yahya & Bakri (2019) in chemistry and mathematics education indicates that learning with QR code-based media can positively affect students' learning outcomes. Furthermore, it is mentioned that many mathematics students using QR code-based learning materials have shown positive responses (Harahap, Harahap, Nasution, Siregar, & Karolina, 2023). Therefore, QR code usage in education can be employed to support direct learning. Unlike the previous five studies, this research develops learning media in the form of QR code-based emodules containing the life cycle of animals living beings for fourth-grade students. The goal is to produce high-quality media, examine student responses to the developed media, and assess its feasibility and effectiveness.

QR code is a two-dimensional barcode that can be scanned using a smartphone for quick downloads. QR codes incorporate error correction functions to recover data in case the code is damaged or dirty (Deineko, Kraievska, & Lyashenko,2022; Firliani & Bakti, 2022). There are four levels of error correction that users can select based on the operating environment (Firliani & Bakti, 2022). Increasing the error correction level can enhance error handling capabilities and the QR code's size (Arianti, Darma, & Mahyuni, 2019). According to Sianipar et al. (2021), QR codes can provide a quick response to a URL. Therefore, QR codes can be applied in education, especially in science education, for instance, to direct to a specific learning address related to particular topics (Koreňová & Hvorecký, 2018).

Considering the outlined issues, the objective of this developmental research is to produce an interactive QR code-based E-module that is feasible, based on development, feasibility, and effectiveness, to enhance scientific literacy skills in fourth-grade science education.

Based on the above presentation, QR Code-based learning encourages teachers to be more creative in designing lessons and students to become more active in the learning process. The problems that are present are the low literacy

skills of students in the field of science education, the lack of ability in the field of digital-based technology for science literacy learning, describing alternative solutions to improve science literacy in elementary school students. The development of learning materials in the form of QR Code-based E-Modules aims to enhance higher-order thinking skills in thematic learning. This research aims to develop, validate, and assess effectiveness Development of QR Code-Based digital media to enhance scientific literacy skills in the teaching of natural sciences. The research design follows the Research and Development (R&D) method, specifically the Richey and Klein method, consisting of three stages: Planning, Production, and Evaluation.

METHODS

This research uses the Research and Development method to produce a product.The development method utilized in this study was the Richey and Klein method, a Research and Development (R&D) development model.The Richey and Klein method is a systematic approach that involves design and research in the context of learning development or the development of educational products. It encompasses a systematic process for designing, developing, and evaluating learning products. The PPE model used in this study is the Richey and Klein development model. The development research was conducted through three stages: (1) planning, (2) production, and (3) evaluation, as outlined by Sugiyono (2018). This research employed both quantitative descriptive analysis and qualitative descriptive analysis. The quantitative descriptive analysis technique was used to process data obtained from the product testing questionnaire and presented in percentage descriptions. The formula used to calculate the percentage for each subject is as follows:

Figure 1. PPE Model (Sugiyono, 2018)

Research and development in this study involved only three stages of the Richey and Klein development model. The subjects involved in this study were 23 fourth grade students at Madrasah Ibtidaiyah Muhammadiyah 01 Ciputat, who participated as respondents in the field test, which consisted of one to one evaluation, small group, and field tests.

Research and Development Procedure based on the Richey and Klein Development Model is detailed as follows:

a. Planning Stage

This phase begins by analyzing the needs in the field based on research and literature studies. Field problem analysis is conducted through school interviews with teachers, distributing questionnaires to students, curriculum analysis, and

literature review. Afterward, a product design is created to address the identified issues.

b. Production Stage

Following the planning stage is the production stage, where the product is developed. In this phase, activities include creating learning materials in the form of professionally assisted PDF comics. Several steps in this stage include the systematic creation of e-modules, software processing, design planning, instructions on using QR code scans on Android phones and developing learning syntax.

c. Evaluation Stage

In this stage, the product is tested and assessed for how well it meets the feasibility criteria through validation by subject matter experts, media experts, language experts, and teacher evaluation.

The data analysis technique employed in this research is through expert review, one-to-one, then continued through small groups, and field tests. The development of the digital media report incorporates income data results in the form of descriptive statistics, detailing the description of the data analysis method, to be further processed using quantitative descriptive analysis (Sugiono, 2016, p. 199).

Based on the data from the experts and the student test data, the subsequent data is processed to assess the product's success using a Likert scale. The Likert scale is utilized to measure respondents' attitudes toward a particular aspect expressed through a series of questions with a scale ranging from 1 to 4 (Setyosari, 2015, p. 232)

The researcher uses simple statistics, specifically the Likert scale according to Sugiyono, with scores ranging from 1 to 4. The scoring categories are 1 = very poor, 2 = poor, 3 = good, 4 = very good.

After calculating the results from the expert trials of the QR Code-based digital E-module to enhance student literacy, the researcher will convert qualitative data into quantitative data to measure the product's feasibility. The formula for this conversion is as follows:

$$\frac{\text{Total Score of Data Collection Results}}{\text{100\% Number of Items x Highest Point per Item}} \text{ x}$$

Table 1. Feasibility Scale

Description	Score
Very Feasible	75%-100%
Feasible	50%-75%
Not Feasible	25%-50%
Not at all Feasible	0%-25%

Source: Riduwan in Kantun & Budawati, (2015)

RESULTS & DISCUSSION

The results of developing a QR Code-based digital media design in the form of an E-module for science learning to enhance the literacy skills of fourth-grade

students are presented following the Richey and Klein framework. The outcomes and development of each procedure are detailed through three steps. The following describes each stage:

1. Planning

During the planning stage, prior to creating the QR Code-based digital media product, the researcher collected data and information through a needs analysis by conducting interviews with fourth-grade class teachers and students. The results of the interviews with the fourth-grade class teachers indicated that the availability of learning media at MI Muhammadiyah 01 Ciputat was inadequate or still required additional learning media. Media indicators there are four aspects of appearance, software, implementability. learning indicators there are identifying the cycle of several types of living things that are around us, students analyze the life cycle of animal life, students evaluate, arrange animal life correctly present the life cycle of living things that are around. If the school possesses comprehensive learning media, it can be utilized to facilitate students' understanding of the lessons. Learning media also affects students' engagement in understanding the subject matter. Learning media significantly affects students' involvement in thematic learning, particularly for theme 6, sub-theme 2, "Life Cycle of Metamorphic Animals," as student engagement becomes active when adequate learning media is available.

Furthermore, challenges are commonly encountered during thematic learning, specifically in theme 6, sub-theme 2, "Life Cycle of Metamorphic Animals," due to the limited availability of tangible teaching aids. This limitation results in a lack of interest from students in the learning media. Despite the inadequacy of learning media in the school, teachers do not find difficulty in delivering the thematic lesson on theme 6, sub-theme 2, "Life Cycle of Metamorphic Animals." Teachers make maximum efforts to utilize available resources within the school environment. However, there are shortcomings in the media used by teachers, as the materials are overly simplistic, making it somewhat challenging for teachers to apply them effectively.

In response to the challenges faced at MI Muhammadiyah 01 Ciputat, the researcher was motivated to develop QR Code-based digital media. Based on the gathered information, QR Code-based digital media, or in the form of an Emodule, is considered a potential bridge for students to comprehend lessons. Additionally, QR Code-based digital media not only enhances science literacy skills in learning but also contributes to improving overall literacy in children. Suppose students show more interest in visually dominant reading materials than those primarily reliant on text, such as textbooks or other reading materials. In that case, implementing QR Code-based digital media can be beneficial.

A fourth-grade class teacher stated that QR Code-based digital media, when applied to students, can help enhance their literacy skills, fostering interest during the learning process and making students more effective. Considering the rapid development of digital technology, the fourth-grade class teacher at MI Muhammadiyah 01 Ciputat hopes that creating the QR Code-based digital media will not only captivate students but also encourage critical thinking, creativity, and contribute to their success.

Based on the researcher's observation above, the researcher concludes that the QR Code-based digital media developed to enhance science literacy will be tailored to the needs and preferences of students. The media will predominantly feature images, typical of digital E-modules, with various colors to make it visually appealing. The design will be created using the graphic design application Canva on A4-sized paper, focusing on theme 6, which consists of sub-theme two related to the subject of science with content on the life cycle of metamorphic animals.

The QR Code-based digital media, in the form of an E-module, will include introductory notes, a table of contents, images, videos, QR Code scans, and evaluation questions. These components are incorporated to enhance science literacy, and the E-module format is intended for assessing students' learning outcomes from the QR Code-based digital media content.

The development of the QR Code-based digital media in the form of an E-module aims to improve literacy skills among elementary school students. The goal is to generate interest in reading among students. Additionally, the researcher hopes that the QR Code-based digital media will facilitate students' understanding of the lessons, leading to the emergence of effective, criticalthinking, creative students who can achieve success in the learning process.

2. Production

The development process of the QR Code-based digital E-module begins with the creation of the cover, followed by the collection of materials from various sources, including the internet and textbooks. The researcher designs the content to be easily readable and understandable for students. The material is then structured to be as visually appealing as possible, considering both content and the systematic presentation. After designing the content, it is integrated into QR Codes.

a. Systematic E-module Creation

Based on the analysis conducted by the researcher and the completion of the design stages, the next step is the production of the QR Code-based digital E-module product. The structural design of the QR Code-based digital E-module is carried out using the Canva application, starting from the cover to the layout of paragraph content. The textual content is created using Microsoft Word, Canva, Heyzine, and QR Code Monkey applications. The designed content of the QR Code-based digital Emodule is then saved in PDF format and uploaded to applications such as Heyzine and Blogger, accessible on both laptops and smartphones and formatted in A4 size.

The subsequent step involves the assembly of the QR Code-based E-module using various techniques in its creation until it takes the form of an electronic module. The basic techniques used in producing the QR Code-based digital E-module include the design and creation process. The structure and design of the developed QR Codebased digital E-module product can be seen in the visual representation of the production process.

1. Designing the QR Code-Based E-module Production

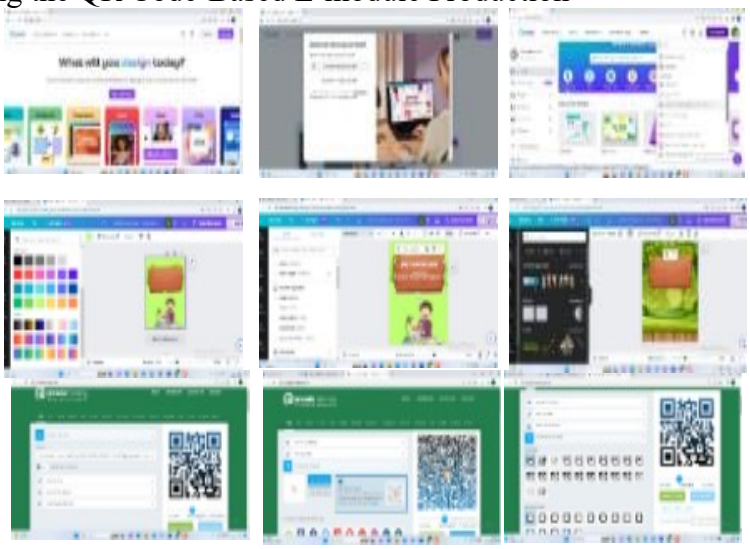

Figure 2. QR Code-Based E-module Production Process

2. Preface

This digital E-module includes exercises to assess students' understanding of the material covered in the module. The digital module focuses on the topic of natural science, specifically discussing the material on the metamorphosis of living creatures. In creating this module, the author has concentrated on the metamorphosis of living creatures according to the basic competencies and feels there are still shortcomings, both in terms of writing techniques and content, considering the author's capabilities.

3. Table of Contents

The table of contents typically consists of a list of chapters or sections, titles or subtitles, and page numbers where each chapter or section begins. An example of the table of contents for the QR Codebased digital E-module on "Metamorphosis in the Life Cycle of Animals" is provided, including page numbers on the right side for each chapter or sub-chapter. The content covers the definition of the growth and development of living organisms, a conversation story about pet care, the definition of the life cycle, and the definition of metamorphosis, divided into two parts: with and without metamorphosis. It also includes information on the life cycle of animals.

4. E-module Description

The cover includes, among other things, the title of the emodule "Metamorphosis in the Life Cycle of Animals," the subject name Natural Science, learning topics on the growth and development of living organisms, a conversation story about pet care, the definition of the life cycle, the definition of complete and incomplete metamorphosis, accompanied by images of the life cycle of animals with and without metamorphosis, class, author, and school logo. Preface Contains information about the role of the e-module in the learning process. Table of Contents Outlines the framework of the emodule. Next is an introduction to basic competencies and indicators in the science content that will be studied in the e-module. To help student comprehension, the e-module should be designed

attractively, integrating text, images, videos, links, and QR Codes; a bibliography is included.

b. Software Processing

The process of creating the E-module with QR Codes involves integrating various applications. The E-module is created using Canva for design, Dr. Monkey for QR Code generation, Heyzine for forming the digital E-module, utilizing attractive fonts, colors, and adjusting the background within the module itself. Once the design is complete, it is compiled into a PDF format, downloaded through the Heyzine application, and a link is generated on Heyzine. This link is then inserted into the Dr. Monkey application in the form of a QR Code.

c. How to Use QR Code Scanner on Android Phones

1. Students can scan the QR code by opening the camera application and directing the phone towards the QR code.
2. Students can use the Google Lens application to scan the QR code.
3. Hold the camera about 30 cm away from the QR code. Then, slowly move the camera closer to the QR code.
4. QR Codes are present on several pages of the Digital E-module.

After production, the QR Code-based digital E-module undergoes validation by three experts: a media expert, a language expert, and a content expert. Data on the product's feasibility and expert feedback are obtained during the evaluation phase. The feedback is then used for revisions. This validation process involves a single stage and is conducted by media, language, and content experts. The following are the average percentage results of media, language, and content validation.

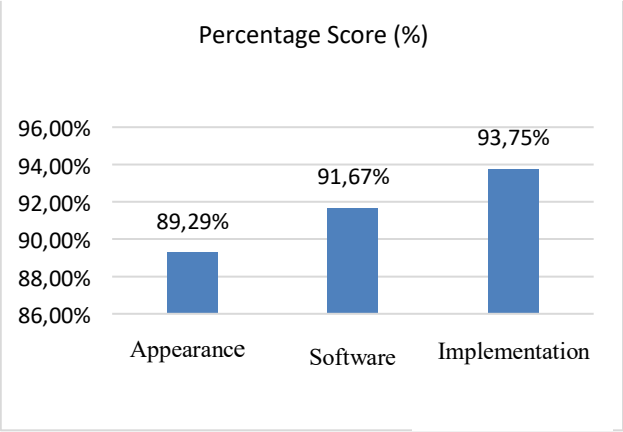

Figure 2. Media Expert Validation Results

Based on the assessment by media experts, the media validation results for the QR Code-based digital E-module reached 91.57% and were categorized as excellent.

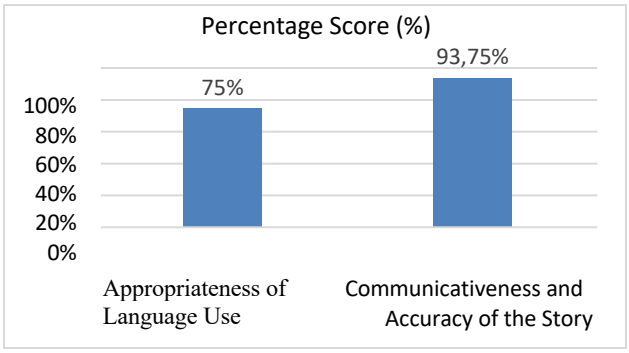

Figure 3. Language Expert Validation Results

Based on The assessment of content experts, the language feasibility test results for the QR Code-based digital media E-module reached 84.38% and were categorized as excellent.

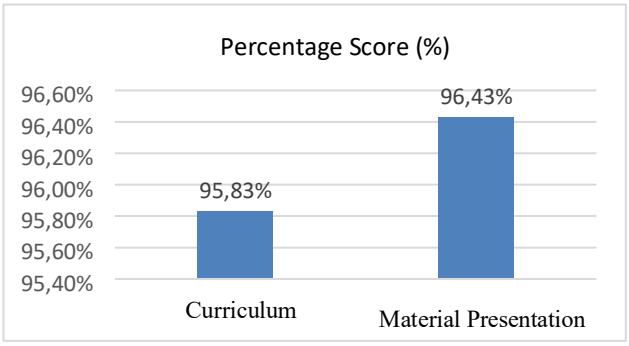

Figure 4. Results of Content Expert Validation

The results of the content feasibility test for the QR Code-based digital media Emodule, based on language experts, reached 96.13%, indicating a good level of feasibility.

Validation of the developed product against the media, as shown in Figure 2.3.4, indicates an average percentage of media feasibility at 91.57%. Language validation obtained an average percentage of 96.13, and material validation obtained an average percentage of 84.38. The overall average value falls within the very feasible category, according to the criteria outlined by Riduwan in Kantun & Budawati (2015), where the range of 75%-100% is categorized as highly feasible.

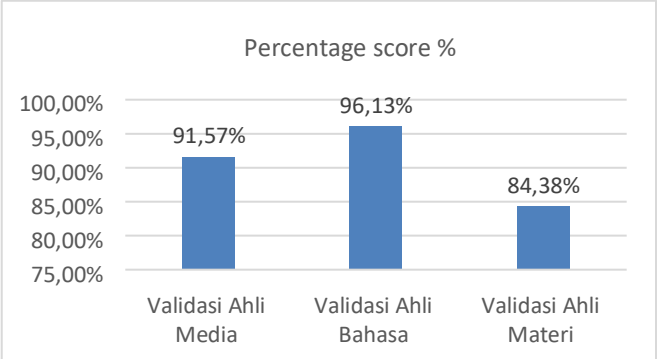

Figure 5. Results of Expert Validation

The next stage is the trial stage, aiming to assess the effectiveness and student response to the developed learning material. In this stage, one-to-one trials, small group trials, and field trials were conducted. One-to-one trials involved three students, small group trials involved five students, and field trials involved 23 students. The results obtained from the one-to-one and small-group trials are as follows.

Table 2. One-to-One Trial Results

Assessment Aspect	Obtained Score	Max Score	Score %	Feasibility Category
Language	22	24	91,67%	Very Feasible
Appearance	42	48	87,50%	Very Feasible
Implementation	44	48	91,67%	Very Feasible
Total		120	270,85%	Very Feasible
Aver ıge Score			90,28%	Very Feasible

Table 3. Small Group Trial Results

Assessment Aspect	Obtained Score	Max Score	Score %	Feasibility Category
Language	37	40	92,50%	Very Feasible
Appearance	75	80	93,75%	Very Feasible
Implementation	75	80	93,75%	Very Feasible
Total		120	280%	Very Feasible
Average Score			93,33%	Very Feasible

Based on Table 2.3, the average percentage result of the one-to-one trial phase is 90.28%. This indicates that the developed QR Code-based digital media Emodule is highly feasible. The feedback obtained during the one-to-one trial included:

1) Some sentences are unclear and difficult to understand.
2) The choice of background color in the material for theme six sub-theme 2 is not appropriate and slightly distracting.

From the previous stage, the one-to-one trial, the feedback from students becomes the basis for revising the QR Code-based digital media E-module. The revised product is then tested in a small group. In this stage, the trial is conducted by five students selected based on different levels of knowledge using a questionnaire consisting of 10 questions. The results of the small group trial can be seen in Table 3.

Based on Table 3, the average percentage result of the small group trial phase is 93.33%. This indicates that the developed QR Code-based digital media Emodule is already good. The feedback obtained during the small group trial includes the suggestions to add animations of animals and people in the electronic module and to clarify confusing questions for students. The following is the

appearance of the electronic module after being improved based on the feedback and suggestions from the validator.

The next step involves the researcher conducting field testing. The data obtained from the field testing results include the students' cognitive abilities in science learning, comprising evaluation scores and competency tests within the cognitive domain, specifically cognitive aspects C4 to C6. Additionally, during the learning process, it is expected that students develop 4C skills, including critical thinking, communication, collaboration, and creativity. The field test aims to assess the effectiveness of learning using the QR Code-based digital E-module. The field test was conducted with 23 fourth-grade students using a pretest-posttest design. The use of the QR Code-based digital E-module was found to enhance students' critical thinking skills in solving challenges encountered during the project. Students were given a pretest before implementing the QR Code-based digital Emodule in the learning process. The pretest consisted of 10 multiple-choice questions and five fill-in-the-blank questions. After the pretest, the learning process involved a project activity using the QR Code-based digital E-module to enhance science literacy in science learning.

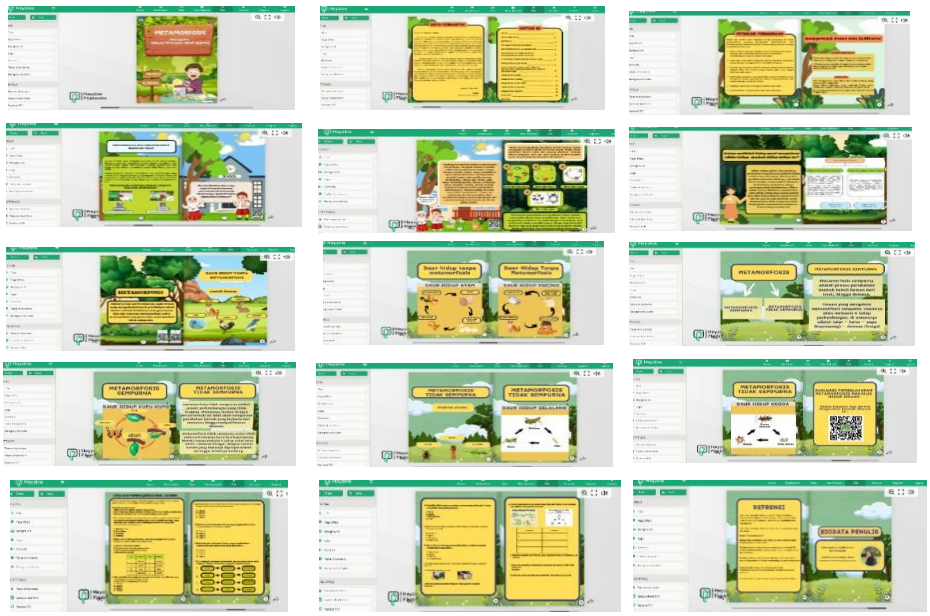

Figure 5. Revised Product Display

Table 4. Description of Pretest and Post-test Results

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE TEST	63.4783	23	6.29480	1.31256
	POST TEST	89.1304	23	7.78287	1.62284

The above output shows the summary statistics of the descriptive results for both samples or pretest and post-test data.

Table 5. Description of Sample Correlations Results

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PRE TEST & POST TEST	23	-.237	.276

The second output displays the correlation or relationship between two variables, namely pretest and post-test, while the third output is.

Table 6. Paired Sample T-test Results

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE TEST - POST TEST	-25.65217	11.10941	2.31647	-30.45624	-20.84811	-11.074	22	.000

Based on Table 6, the analysis of the pretest and post-test results for students reveals that the data normality test conducted to assess the effectiveness of the QR Code-based digital learning media through the T-test can be observed in the analysis of the average values of the pretest and post-test for fourth-grade students. The results indicate a significant difference with both pretest and post-test, obtaining a significance value of 0.000 below 0.05. Therefore, it can be concluded that the QR Code-based digital media is highly effective in improving student learning outcomes. The student's average score and response related to literacy obtained a score of 85.74%, categorized as excellent. To verify the accuracy of this data, a paired sample t-test using SPSS was conducted, resulting in significance = 0.000 < 0.05. Thus, it can be concluded that the implementation of QR Code-based digital media in science learning has a significant impact on improving student learning outcomes.

3. Evaluation

In this evaluation phase, the researcher presents the product outcomes to experts. Once declared valid, the next step involves testing the product in a one-toone evaluation. This trial is conducted in a fourth-grade class by interviewing three students about the generated product. After testing the product with the respondents, the researcher gathers comments and suggestions, leading to product revisions.

Upon completing the revision phase, the researcher conducts another field trial, specifically a small-group field trial, by testing the product on five students. The students are then provided with a questionnaire to assess the resulting product. Following the small-group field trial, the researcher improves the product based on feedback from the respondents.

The final testing phase is the field test involving 23 students. The researcher distributes a questionnaire to evaluate the product once more. In conclusion, the feedback and suggestions gathered from material experts, language experts, media experts, one-to-one evaluations, small-group field trials, and the final field test are consolidated to revise the product, making it a perfect digital E-module for students' literacy skills.

This research and development effort produces a product in the form of a QR Code-based digital media module for the metamorphosis material of the fourth grade animal life cycle. The product undergoes testing with a small-scale trial involving one-to-one with three students, a small group of five students, a field test, and an effectiveness test with 23 students at MI Muhammadiyah 01 Ciputat. The product covers energy source material to assist students in understanding it better. QR Codes are used to access a website containing the content found in the Heyzine digital E-module. QR Code-based digital media combines concrete traditional learning media and technology. The technology in the product aims to facilitate users' access to enjoyable and practical learning media.

According to Sawitri (2022), technology can enrich teaching experiences and encourage educators to deliver materials more interestingly and interactively. Various online learning environments, applications, and software can help teachers create creative presentations, provide multimedia content, and give students opportunities for deeper learning. Engaging visualizations and the use of multimedia in teaching can also help students understand the material better. With attractive displays and diverse learning methods using technology, learning materials can be delivered more compellingly, making it easier for students to absorb information and retain an understanding of the lesson.

In the results of research and development that has been carried out by researchers, the development of QR Code-based digital media has used research and development with the Richey and Klein model through the planning, production, and evaluation stages of media feasibility can be seen from the results of media validation by three validators, including, media expert assessment reached 91.57% with a very good category, material expert assessment reached 96.13% with a very good category and linguist assessment reached 84.38% good. Based on the results of the experts, QR Code-based digital media is said to be very feasible.

Furthermore, the one-to-one test scored 90.28% with a very good category and the small group test scored 93.33% with a very good category, so this product is said to be very feasible. So it can be concluded that the development of QR Code-based digital media is very feasible to use in thematic learning for grade IV elementary schools, the results of the effectiveness test conducting the QR Code-based digital media learning t test can be seen from the analysis of the average value of the pretest and posttest of grade IV students. With pretest and posttest obtained 0.000 below 0.05, from these results shows a significant difference, it can be said that digital media is very effective because it can improve student learning outcomes. The value and response of students related to literacy obtained an average score of 85.74% with a very good category. to find out the truth of these data, a paired sample t test was conducted using SPSS. The results obtained significance = 0.000 <0.05, so that the application of QR Code-based digital media in science learning has an influence on improving student learning outcomes.

CONCLUSION

The E-module teaching material based on the QR Code developed in this study is highly feasible for implementation in the learning process, as evidenced by

the validation results from media, language, and content experts. Furthermore, the electronic module based on QR Code received positive responses from one-to-one, small group, and field tests, as well as effectiveness assessments conducted with students. The QR Code-based electronic module is attractively presented, incorporating images, videos, links, and QR Codes. Based on the field test results, this digital media E-module based on QR Code proves effective in enhancing higher-order thinking skills, critical thinking, and is an efficient tool for training students' scientific literacy. It can serve as a useful tool to facilitate self-directed learning for students.

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