



The Development of Interactive Picture Card Media with QR Code to Improve IPAS Learning Outcomes

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Abstract: One element that encourages increased student focus and makes it easier to understand the subject matter is learning media. This study aims to create and evaluate interactive picture card media with QR codes to enhance the learning outcomes of grade IV students. The Research and Development (R&D) method, which is modified into nine phases, was employed in this study. The research subjects were teachers, students, media specialists, and subject matter specialists. Data collection was conducted through observation, surveys, interviews, and documentation. The t-test, n-gain, and normality tests are the data analysis methods used in this investigation. The design validation results get very feasible criteria from media experts (92.28%) and material experts (92.18%). The results of the classroom teacher's response were 93.75%, and the student's response was 94.27%, which are feasible criteria. The significant effectiveness test using the t-test yields a p-value of 0.000, indicating that H_a is accepted while H_o is rejected. The n-gain calculation is 0.6915, which falls under medium criteria. Thus, the interactive picture card media with the QR Code that has been developed is very feasible and effective for improving learning outcomes. These findings contribute to the development of innovative learning media that can enhance student learning outcomes and offer new alternatives for teachers in delivering lesson materials, especially at the elementary school level.

Keywords: learning media, picture cards, QR codes, learning outcomes

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Introduction

Education is a lifelong learning process that benefits everyone in various settings (Pristiwanti et al., 2022; Suratimah et al., 2023). Education is the process of imparting skills, values, and knowledge. Education is more than just academic knowledge; it also helps people become better members of society. The standard of education determines the calibre of human resources and the country's level of advancement. As a result, the current era demands the integration of technology into the learning process (Alobaid, 2020; Desyandri et al., 2024). This is relevant to Education 4.0, which utilizes technological advances that include components such as competencies, learning methods, information and communication technology, and infrastructure (Miranda et al., 2021). This aligns with Qureshi et al. (2021), who state that Education 4.0 brings changes to the world of education, but also creates a gap between current skills and the skills required to meet current educational needs. To overcome this, education must prioritize the mastery of subject matter and critical thinking skills while also encouraging collaboration and effective communication (Arifin et al., 2021; Elisa et al., 2022).

The current curriculum is the independent curriculum. In the Merdeka Curriculum, teachers and students are free to create more interactive learning based on student needs, especially in IPAS subjects in elementary schools, which require more creative learning methods and the use of learning media. Learning media is a tool for communication between teachers and students (Sutarto et al., 2020). Effective IPAS education can develop students' understanding and stimulate their interest in learning, as students' motivation to learn stems from within themselves, ultimately determining their learning

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success (Ghazali et al., 2022; Pangestu et al., 2024). The research by Zhou et al. (2022) suggests that the concept of learning is closely tied to motivation, strategies, and learning outcomes. With effective learning media, student learning motivation increases, and students remember the material more easily, thereby achieving maximum learning outcomes. This is supported by research from Atma et al. (2021) and Harisanty et al. (2020), which indicates that learning motivation significantly impacts learning outcomes. Learning outcomes are the achievements of students after conducting learning activities. However, currently, developing learning media presents several challenges. According to Firmansyah et al. (2024) and Sulthon et al. (2021), teachers face challenges in creating learning media due to limited facilities, funds, and time. Teachers can motivate themselves and strengthen their knowledge by developing strategies and exploring various learning models (Darmawati & Mustadi, 2023). Based on these conditions, motivation and learning outcomes have not been maximised at the elementary school level, particularly for subjects that require visualisation of complex concepts, such as IPAS.

Currently, many problems are still being solved. The fact is that teachers are still not creating optimal learning tools that align with student characteristics and address the challenges of 21st-century learning (Kiptiyah et al., 2023). This is also the case at Kalibanteng Kidul 03 Elementary School Semarang City. Researchers identified several issues based on the results of interviews and observations conducted, particularly in IPAS learning in class IV. One is that the quality of IPAS learning needs to be improved. Learning Science of Nature and Social (IPAS) in class IV is still centred on the teacher (teacher-centred), so learning is considered boring. This is due to the limited availability of learning media, which is still primarily limited to teacher books, student books, and YouTube videos. The limited learning resources cause students to be less interested in the learning process, resulting in a lack of understanding of the material. This results in low IPAS learning outcomes, especially in the "Energy Transformation Around Us" material. With adequate learning resources, students will more easily understand the material (Setiawan et al., 2023). To facilitate student understanding, the optimal use of learning media is necessary to support teachers. Innovative media development, such as interactive picture card media with QR codes, can overcome this problem.

An alternative method for teaching abstract concepts in IPAS is the use of interactive picture card media with a QR Code, which displays pictures and explanations. This aligns with the findings of Shafa et al. (2022), as it incorporates illustrations and educational content that facilitate learning, and picture card media is suitable for primary school levels. Game-based learning materials can improve educational accessibility for all groups. Es-Sajjade & Paas (2020) also stated that game-based learning media can increase educational accessibility for all groups. These flashcards are suitable for meaningful learning, especially in elementary schools, as they consist of pictures, words, phrases, and letters (Sari et al., 2023). As times change, the medium of picture cards can be altered to enhance their functionality. Researchers altered the photo card in this study by adding a QR Code that provides information about the subject. A QR code is a two-dimensional barcode that can be read using a smartphone or web application (Marwan et al., 2020). To raise the standard of instruction in elementary schools, using QR Code-based learning resources at the elementary level is legitimate, helpful, and successful (Axelino & Ahmad, 2021). Students might have experiences during the learning process thanks to innovations. This is supported by the findings of earlier research by Rahayu & Jamaludin (2022), which states that picture card media is very effective as a learning medium for elementary schools. This is based on the assessment of media experts categorized as very feasible. Research by Tan & Chee (2021) demonstrates that QR Codes can motivate students to learn because they are easy to use and meet students' learning needs. The objectives of this study are to: 1) develop an interactive picture card media design with a QR Code, 2) examine the feasibility of interactive picture card media with a QR Code, and 3) examine the effectiveness of interactive picture card media with a QR Code. This study makes a significant contribution to education in Indonesia by developing learning media that integrates QR Code technology with interactive picture cards.

Methods

This study employed Research and Development (R&D), focusing on the creation, design, and evaluation of the final product as its key components (Sugiyono, 2021). The results of product research and development, as well as testing of a product's effectiveness, were the focus (Zakir et al., 2021). The Borg and Gall development model was employed in this study. The researchers selected this approach because it was developed by examining the needs and evaluating the product's ability to enhance learning outcomes. Figure 1 shows the 10 phases of the Borg and Gall model include potential issues, data gathering, product design, design validation, design revision, product trial, product revision, trial use, final product revision, and mass production.

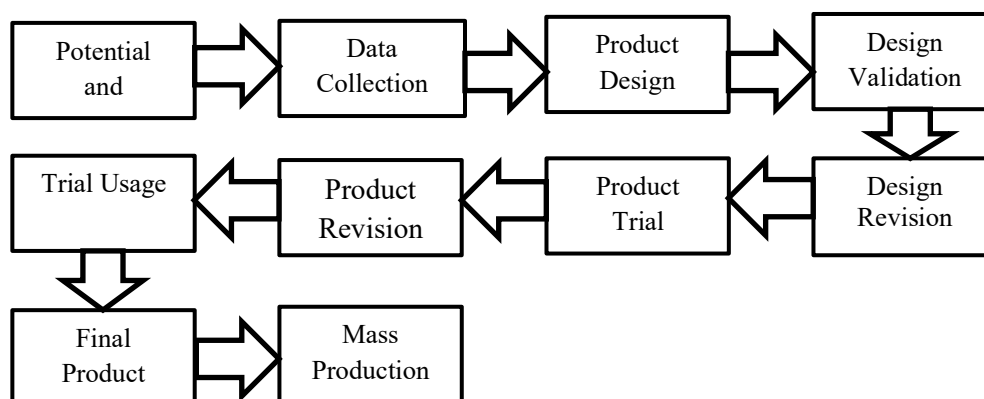


Figure 1. Borg and Gall Development Model (Sugiyono, 2021)

This study created educational materials using picture cards with QR codes. The study's subjects were teachers, students, media specialists, and material specialists. A one-group pretest-posttest design was employed to evaluate the effectiveness of interactive picture card media with QR codes during the product and usage trial phases. The study's population consisted of fourth-grade students from Kalibanteng Kidul 03 Elementary School. The research sample consisted of 28 children, 6 of whom participated in the product trial and 22 in the usage trial. Both test and non-test methods were used to obtain data. Initial observations, teacher and student needs questionnaires, teacher interviews, and data presented during documentation were examples of non-test methods.

Additionally, following the product trial, teacher and student replies, media experts, and material specialists used the questionnaire to evaluate the media's viability. Reliability tests with a rating of 0.816, meeting high criteria, were legitimate because the test instruments used in this study were the outcomes of pretests and posttests administered in class IV before and after media use. The questions' difficulty indexes were categorised as easy, moderate, and challenging. Twenty-five questions were deemed viable for testing as pretest and posttest questions to make up the differential power. The t-test, n-gain, and normality tests were then used to examine the data.

Results and Discussion

Results

To enhance the learning outcomes of the "Energy Transformation Around Us" curriculum for fourth-grade elementary school pupils, this study creates interactive image card content utilising QR codes. The Borg and Gall development paradigm, which encompasses both potential and issues, data gathering, product design, design validation, design revision, product trial, product revision, usage trial, final product revision, and mass production, is employed in this study.

The first step researchers take is to observe preliminary data before conducting their research. During these observation activities, various items are examined, including learning challenges, learning resources, instructors, and students. Student learning outcomes, particularly in the IPAS subject matter "Energy Transformation Around Us," remained subpar after issues with the learning method were identified, specifically the limited use of creative learning tools. Student learning results, which indicate

that 77% of students receive scores below the criteria for achieving learning objectives, further support this.

Following up on the previous step, researchers gather various facts and supporting data at this stage, which serves as the foundation for product design. After discovering issues in the field, academics find the root causes of current issues. After that, researchers gather various data to design products anticipated to solve current issues. To determine the needs of teachers and students, the data-gathering method involves observation, interviews, documentation, and questionnaire creation, as well as reviewing pertinent research papers and literature.

After collecting data, the researchers then designed the product developed in the form of picture cards. The first stage involves compiling an interactive picture card media product design prototype with a QR code, which serves as an initial description or simple prototype of the product to be developed. The next step after creating a prototype is to develop a prototype by preparing picture card media for the learning material as a whole. At this stage, researchers also determine the type of material and the proper size and content of the developed media. Interactive picture card media design incorporating QR codes is tailored to the characteristics of elementary school students.

At the design validation stage, the design will then be validated to assess whether the media made is practical and suitable for use in learning. Media and material experts assess the feasibility of interactive picture card media with QR codes. The following are the results of a feasibility study on interactive picture card products with QR codes, conducted by media and material experts.

Table 1. Media and Material Design Validation Results

	Media Expert	Material Expert
Score obtained	74	55
Maximum Score	83	60
Percentage	92.28%	92.18%
Criteria	Very Feasible	

According to Table 1, the results of the media experts (92.28%) and material experts (92.18%) are able to determine that image card media can be tested in the field. The outcomes of the media and material experts' validation are as follows.

Following media validation, researchers made design changes to lessen product flaws. Following a validity test of the product design, the experts offered their opinions and recommendations, and researchers updated the media accordingly. Following the change, the design was reviewed before being deemed ready for testing. An example of interactive picture card content created by academics using a QR code is shown on Figures 2 and 3.



Figure 2. Packaging and Interactive Picture Card Display with *QR Code*



Figure 3. Scan Display of Interactive Picture Card Media with *QR Code*

Researchers employed a purposive sampling strategy in product testing, selecting the sample based on specific criteria (Sugiyono, 2021) and completed in three phases. Before using the material, students must complete a pretest to gauge their level of comprehension. Using interactive image card media with QR codes, the second level involves learning. After using the press, students complete a posttest in the third step to gauge their learning outcomes. Following the instruction, teachers and students responded to questionnaires that asked for their opinions on the media and the educational process. Following the small-scale product trial, paired t-tests were used to examine the data to find differences between the pretest and posttest outcomes.

Table 2. Results of the Paired T-Test on Product Trial

		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	Pretest - Posttest	-32.000	9.798	4.000	-42.282	-21.718	-8.000	5	.000

Table 2 showed a significant value. (2-tailed) shows $0.000 < 0.05$, indicating that there is a statistically significant difference between the pretest and posttest results. Researchers also conducted the n-gain test to determine the extent to which learning outcomes improved after using interactive picture card media with QR codes.

Table 3. N-Gain of Product Trial Results

Pretest Average	Posttest Average	Average Difference	N-Gain	N-Gain %	Criteria
49.33	81.33	32	0.6448	64.48%	Medium

Table 3 reveals that after the product trial, the product will be revised based on the feedback from the teacher and student response questionnaires. The media will be revised according to the suggestions and input from teachers and students. However, there was no revision at this stage because neither the teachers nor the students provided suggestions or input. The questionnaire results showed that the media was very feasible to use in the trial.

The next stage is the usage trial. Twenty-two class IV Kalibanteng Kidul 03 Elementary School students participated in the usage trial. The purpose of the usage trial is to measure the product's effectiveness by conducting a test. This test consists of pretest and posttest questions before and after using the media to determine how effectively the product improves student learning outcomes. Table 4 shows the results of the normality test in the usage test using the Shapiro-Wilk formula.

Table 4. Normality on Trial Use

Tests of Normality						
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.167	22	.113*	.971	22	.743
Posttest	.199	22	.023*	.936	22	.162

A significant result of $0.743 > 0.05$ was obtained from the Shapiro-Wilk test for the Pretest normality test, while $0.162 > 0.05$ was obtained from the Posttest value. Thus, the results of the extensive Pretest and Posttest scores of Kalibanteng Kidul 03 Elementary School fourth-grade pupils can be said to be regularly distributed. To determine whether there was a significant difference between the average pretest and posttest findings, researchers also used a paired t-test or a test for the average difference between pretest and posttest. The paired t-test results for the utilization trial are shown on Table 5.

Table 5. Paired T-Test on the Usage Trial

Paired Samples Test									
Paired Differences									
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest - Posttest	-31.364	8.671	1.849	-35.208	-27.519	-16.965	21	.000

According to the paired t-test results, there is a significant difference between the pretest and posttest findings, with a p-value of Sig. (2-tailed) $0.000 < 0.05$. To determine the impact of interactive picture card media with QR codes on learning outcomes, researchers also administered the N-gain test. The following table displays the results of the n-gain test.

Table 6. N-Gain of Usage Test Results

Pretest Average	Posttest Average	Average Difference	N-Gain	N-Gain %	Criteria
54	85.36	31.36	0.6915	69.15%	Medium

Table 6 reveals the results of the average increase test (n-gain) in the large-scale usage trial which show that class IV students of Kalibanteng Kidul 03 Elementary School, who used interactive picture card media with QR Codes, totalling 22 students, increased by 69.15% with moderate criteria. The average difference between pretest and posttest results is 31.36%. Thus, interactive picture card media with QR codes proved effective in helping students improve their learning outcomes on the material related to energy transformation around us.

The final product revision is made if the media's use in the usage trial is weakened. Final product revisions were not carried out because the developed products were feasible and effective in facilitating learning after several trials. In this study, researchers did not carry out mass production because the media developed had a concrete form, namely picture cards, so limited resources were a factor to consider.

Discussion

Development of Interactive Picture Card Media with QR Code on Energy Transformation Material Around Us

This research produces interactive picture card media with QR codes. The basis for developing this media is the research of Alwi & Aulia (2023) and Saragih et al. (2024). Learning media significantly affects student learning motivation, so the use of learning media can increase student learning motivation. Anggito & Sartono (2022) also believe that the learning process using media can improve students' understanding and ability to absorb material. The opinion of Ardiansa et al. (2023) also supports this, stating that picture card media can make the learning process innovative and interactive, thereby making it more engaging and less passive. Harisanty et al. (2020) and Sukerti et al. (2020) also

found that picture cards were considered fun, which led to students being very enthusiastic. Fitriana & Setyasto's (2023) research also mentions that QR Code-based media can present material in a more varied and interesting way by combining text, images, audio, and video. Therefore, researchers assume that using picture card media will make learning more engaging and interactive, thereby increasing student motivation to learn.

The creation of QR code-enabled interactive picture card content is suited to the needs of elementary school pupils. Children can use logic to reason at the concrete operational level, but are still restricted to something tangible and actual (Imanulhaq & Ichsan, 2022). According to Fitriyadi & Wuryandani (2021), the incompatibility of methods and student characteristics is one of the factors in students' critical and creative thinking abilities. It is essential to foster students' critical and creative thinking skills, as critical thinking skills stimulate the development of innovative thinking (Nawang Sari et al., 2022; Triwahyuningtyas et al., 2020). As a result, scientists created media with tangible shapes and pictures of actual objects in the kids' environment. The use of QR codes also facilitates teachers' ability to provide web addresses to students, thereby encouraging their independence (Widyasari et al., 2019). The creation of picture card media is also based on issues that arise in class IV Kalibanteng Kidul 03 Elementary School, where students' learning outcomes regarding the energy transformation material around us are subpar, and because there is a dearth of learning media, teacher and student books and YouTube videos are still the only options available. Researchers investigated the demands of both teachers and students in its development. The needs analysis's findings declare the need for engaging learning media advances. Fatkhiyani & Dewi (2020) stated that learning media in the form of images could overcome this problem. Therefore, picture cards were chosen to facilitate IPAS learning in grade IV, especially in the material on energy transformation around us.

Interactive picture card media with a QR Code is accessed by scanning the QR Code located on the back of the card using an Android cellphone via Google, to obtain more complete material information. This media is printed with a size of 13.3 cm in length and 9 cm in width. Interactive picture card products consist of packaging boxes, instructions on how to use them, and picture cards, totalling 32. The picture cards contain the developer's profile, learning objectives, material explanations, student worksheets, and several questions that must be answered on the picture cards. Some advantages of interactive picture card media with QR codes are that they are flexible and easily accessible, which aligns with the current digital era. In addition, interactive picture card media with QR codes has several disadvantages. One limitation is that it requires an internet connection and is compatible with limited electronic devices, such as student cell phones.

Feasibility Test of Interactive Picture Card Media with QR Code on Energy Transformation Material Around Us

Interactive picture card media with QR codes has undergone feasibility testing by two media experts and material experts. This expert validation was conducted prior to field testing to assess the quality and feasibility of the developed media. The feasibility assessment is carried out using instruments prepared by researchers based on predetermined references. Validation covers various aspects, including visual appearance, operation, material, and language suitability. Furthermore, the experts provided suggestions and input related to the media developed. The improvements made by the researchers included revisions to the instructions for use, the packaging of the box, the addition of a bibliography, sentence structure, adjustments to sample images that incorporate daily life, and the inclusion of concept maps. Then, after making improvements, the media were consulted again.

The final assessment from media and materials experts indicates that interactive picture card media with QR codes can be effectively tested in the field. This is supported by the acquisition of scores from media experts of 92.28% and from material experts of 92.18%, both of which are feasible. This feasibility study demonstrates that the media were developed with consideration for aspects such as attractive and clear graphics, the suitability of the material in relation to learning objectives, the characteristics of grade IV students, the ease of operation of the QR Code feature, and the presentation of accurate and relevant information. In addition, suggestions for improvement from experts have been implemented, thereby enhancing the overall quality of the media.

The suitability of the media developed is based on relevant previous research findings by Audia et al. (2021), taking into account design, content, and materials, supported by media validation of 91% and material validation of 90%. The study claims that picture card media is valid and valuable for

learning because it includes a QR Code that facilitates students' comprehension of the content, according to additional research by Arisandi & Putra (2022) is a viable image card medium for learning, as it engages students more effectively. Further research by Anggraeni et al. (2022) shows that the average increase in learning interest was 22.24%. Based on these findings, the integration of QR codes in physics learning modules is effective in increasing students' interest in learning.

Test the Effectiveness of Interactive Picture Card Media with QR Code on Energy Transformation Material Around Us

The efficacy of interactive picture card media with QR codes was evaluated through small-scale product and usage testing. Six samples—two from the top two ranks, two from the middle ranks, and two from the bottom ranks—were selected using a purposive sampling strategy for the small-scale product testing. Twenty-two samples from class IV Kalibanteng Kidul 03 Elementary School were used in the usage testing. The average pretest score in the product trial was 49.33, while the average posttest score rose to 81.33. The product trial's paired t-test indicates that H_a is accepted and H_o is rejected, with a sig. (2-tailed) of $0.000 < 0.05$. After using the media, learning outcomes improved by 32%, according to the product trial's n-gain value of 0.6448, which meets the medium criteria. Following the product trial, a questionnaire on the media was delivered to teachers and students.

At this point, the teacher was also given a questionnaire about learning with interactive picture card media that included QR codes. Following the percentage calculation, the average percentage of 93.75% for the teacher's response and 94.27% for the students' responses was determined to be highly practicable. The pretest score on the usage test was 54%, and the posttest score was 85.36%. The usage trial's paired t-test indicates that H_a is accepted and H_o is rejected, with a sig. (2-tailed) of $0.000 < 0.05$. Additionally, the n-gain test findings show increased learning outcomes following the use of the media, with a medium criteria value of 0.6915.

Interactive image card media with QR codes has a considerable impact on student learning outcomes, according to the results of a paired t-test analysis on product and usage trials. The average student learning outcomes before and after using the media differ, according to the paired t-test study. Additionally, integrating interactive image card media with QR codes improves student learning results, according to the n-gain test. Numerous elements contribute to the effectiveness of interactive picture card media with QR codes in enhancing learning outcomes and comprehension of energy transformation content. First, picture cards offer qualities that draw attention and encourage student involvement in the educational process. Picture cards have the potential to make learning more engaging, taking the form of cards of a specific size that contain educational material (Febriyanty et al., 2024; Maharani & Ramadan, 2023). Second, students' comprehension and recollection of the abstract concept of energy transformation are enhanced when images relevant to the subject matter and daily life are used. Third, the QR Code function makes accessing interactive learning materials simple and quick, aligning with today's students' learning preferences. According to Sinaga in Mahendra & Agustiana (2024), QR Codes facilitate the addition of materials, allowing learning materials to be displayed on media and input into the QR Code. Afikah et al. (2022) state that the effectiveness of media can be measured by how precisely and accurately learning objectives are achieved, not only by the ability to achieve goals. Technology-based learning media is very important in improving learning experiences. Some teachers use this technology in classroom learning. However, some teachers also create effective learning media using simple tools.

Developing interactive picture card media with QR codes has a positive impact on both teachers and students. Developing interactive picture cards can motivate teachers to realize that learning is relevant to the latest technological advances. The learning process also becomes more interactive and enjoyable, thereby improving classroom learning quality. For students, this interactive picture card can help improve learning outcomes by delivering material that is more interactive, interesting, and easily accessible via QR codes. This media development can serve as a learning solution that meets the needs of students, is supported by strong validation, and has been tested for its effectiveness in improving learning outcomes.

Conclusion

Interactive picture cards with QR codes have proven to be highly feasible and effective in enhancing student learning outcomes in the IPAS subject "Energy Transformation Around Us" for fourth-grade elementary school students. The feasibility of this medium is evident from expert media validation (92.28%) and expert content validation (92.18%), as well as positive feedback from teachers (93.75%) and students (94.27%). Its effectiveness is demonstrated by a significant improvement in student learning outcomes, as indicated by a t-test value of 0.000 and an average N-gain of 0.6915. Therefore, this media can facilitate more engaging and effective learning for students. This research aims to develop innovative learning media that can be adapted for use with various materials and themes. Thus, the quality of learning and student learning outcomes can be improved.

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