

Developing PANN: a qr-code hybrid simulation for meaningful learning of inter-island trade

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ABSTRACT

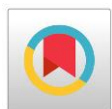
Purpose: to develop and evaluate a qr-code based hybrid simulation learning media called PANN (perdagangan arus niaga nusantara “nusantara trade flow”) for teaching inter-island trade in grade VIII social studies.

Method: this study used a research and development (R&D) design with the ADDIE model to develop a qr-code based hybrid learning media (PANN). The study involved 24 grade VIII students and two social studies teachers. Data were collected through validation sheets, questionnaires, and observations, then analyzed descriptively to assess the product’s validity and practicality.

Findings: the developed PANN learning media was highly valid and highly practical, with an average validity score of 92.18% and a practicality score of 91.58%. The media were effectively integrated into classroom learning, increasing student engagement through an interactive hybrid simulation that combined physical materials and qr-code based digital content. These findings indicate that PANN is feasible as an innovative learning medium for teaching inter-island trade in grade VIII social studies.

Implications: qr-code hybrid simulation media is an effective, practical, and contextually relevant alternative for teaching abstract social studies concepts and supporting student-centered learning in limited digital environments.

Originality: lies in the development of a hybrid learning media that integrates physical simulation, local economic context, and qr-code-based digital resources into a single interactive learning system for teaching inter-island trade in junior high school social studies.



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Introduction

The transformation of education in the era of the industrial revolution 4.0 and the implementation of the merdeka curriculum require a learning approach that is more student-centered and contextual, leveraging digital technology to create meaningful

learning experiences (Langoday et al., 2024). In social studies (IPS), particularly economics, the use of learning media no longer serves solely as a means of conveying information but also helps students construct abstract concepts through active learning experiences (Damayanti & Sukirno, 2025). According to Mayer (2021) multimedia-based learning can improve conceptual understanding by presenting information through a combination of visual and verbal representations. Furthermore, the dual coding theory proposed by Paivio (2014) explains that presenting information in visual and textual forms simultaneously can strengthen students' information processing and memory retention. Therefore, the development of learning media that integrates physical and digital elements is a crucial requirement in supporting the implementation of 21st-century learning.

However, learning conditions at SMP Negeri 3 Kabuh indicate that inter-island trade materials are still delivered through textbooks and conventional, one-way explanation methods. The material's characteristics, which address spatial relationships, commodity distribution, comparative advantage, and interregional interactions, make it difficult for students to visualize the trade process fully. Available media are unable to depict the dynamics of goods flows or the relationship between commodity surpluses and deficits in various regions of Indonesia. Consequently, learning tends to be verbalistic, leading students to memorize concepts rather than understand the underlying economic mechanisms. This situation results in low learning motivation, low student engagement during the learning process, and suboptimal achievement of the competencies expected under the merdeka curriculum.

Various studies have developed digital-based learning media to improve the quality of economics learning. Rosbina et al. (2025); Syaadah et al. (2025) demonstrated that web-based interactive media using the ADDIE model effectively improve learning outcomes because it allows visualization of complex concepts. Other studies have developed qr-code based media, which have been shown to improve students' learning independence and learning outcomes (Lusiani et al., 2026; Widanti & Fathurrahman, 2024). Meanwhile, Hernando & Macías (2023); Rakha (2025); Petkovic et al. (2026) found that qr-code integration can reduce extraneous cognitive load by more efficiently presenting information. Furthermore, Leshchenko et al. (2022); Hernando & Macías (2023) developed a combination of print media and qr-codes for schools with limited internet access. However, these studies still focus on delivering digital or multimedia information individually and have not integrated interactive, activity-based simulations that allow students to experience the inter-island trade process directly. On the other hand, the media developed have not yet accommodated the context of inter-island trade in Indonesia through a hybrid learning approach that combines physical media, qr-codes, and collaborative simulations. Thus, a research gap exists in the lack of learning media that integrate qr-code based contextual economic simulations to facilitate meaningful learning experiences in inter-island trade.

The novelty of this research lies in the development of PANN as a qr-code based hybrid simulation media that combines physical simulation boards, commodity cards, and digital information access to visualize inter-island trade mechanisms in a contextual, interactive, and collaborative manner. This research aims to develop qr-code based PANN media on inter-island trade material for eighth-grade junior high school students using the ADDIE development model. This research aims to produce valid, practical, and effective learning media to support the social studies learning process, while evaluating their feasibility through expert validation, user responses, and implementation in learning to provide a more meaningful learning experience for students.

This research is important because it offers an alternative solution to the limitations of economics learning media, which have so far been static and lacking context. The integration of physical media with qr-code technology enables more flexible learning, without relying entirely on an internet connection, while simultaneously encouraging collaborative, exploratory, and student-centered learning activities. Theoretically, this research is expected to enrich studies on the development of hybrid learning media grounded in meaningful learning in social studies-economics. In practice, PANN media is expected to be an alternative innovation that teachers can use to teach inter-island trade material, improving students' conceptual understanding, learning motivation, and digital literacy, and serving as a reference for the development of contextual learning media for other social studies materials.

Literature review

Meaningful learning

The concept of meaningful learning was first proposed by Ausubel, who emphasized that learning will be more effective when new information is linked to students' existing knowledge structures (Sexton, 2025). In this process, students do not simply memorize facts but build understanding through logical connections between new concepts and prior experiences (Morris, 2025). Meaningful learning positions students as active subjects who construct knowledge through contextual, reflective, and problem-solving-oriented learning activities (Yunita et al., 2025). In line with the implementation of the merdeka curriculum, this approach is an important foundation in social studies learning because it encourages students to understand social and economic phenomena through authentic learning experiences (Suari et al., 2024). In the subject of inter-island trade, meaningful learning can be realized through simulation activities that allow students to directly experience the process of goods distribution, inter-regional interactions, and economic decision-making, thereby making abstract concepts easier to understand.

Multimedia learning theory

The multimedia learning theory developed by Mayer (2021) explains that students learn more effectively when information is presented in a combination of words and images rather than text alone. This theory is based on three main assumptions: humans have two information-processing channels (verbal and visual), working memory capacity is limited, and learning occurs through the selection, organization, and integration of information. Therefore, material presentation needs to be designed to optimize both channels without causing excessive cognitive load. In this study, multimedia principles were applied through the integration of physical media in the form of simulation boards and playing cards with digital content accessed via qr-codes. This combination is expected to facilitate students' understanding of the relationships among concepts in the inter-island trade material through a more concrete, engaging, and interactive presentation of the material.

Dual coding theory

The dual coding theory proposed by Paivio (2014) holds that humans process information through two complementary representational systems: the verbal and visual systems. These two systems work simultaneously to shape understanding, so that information conveyed through text and visuals is more likely to be understood and

remembered than information presented in only one form. In social studies learning, this theory is highly relevant because many economic concepts require visual representation to facilitate student understanding. The development of PANN media utilizes the principle of dual coding by presenting inter-island trade information through maps of Indonesia, commodity cards, distribution symbols, and visualizations of trade flows, combined with digital explanations via qr-codes. The integration of these two forms of representation is expected to improve students' conceptual understanding.

QR-code based learning media

QR-codes are a technology that allows the storage of various types of digital information, such as documents, images, videos, audio, and links to learning resources, which can be accessed quickly on mobile devices (Hernando & Macías, 2023). In education, qr-codes have emerged as a medium that connects printed teaching materials with digital learning resources, creating a more flexible and interactive learning experience (Ibrahim et al., 2025). Widanti & Fathurrahman (2024) explain that the use of qr-codes can increase students' learning independence by providing easy access to various information sources. In addition, Hernando & Macías (2023); Rakha (2025); Petkovic et al. (2026) state that integrating qr-codes into learning media can reduce extraneous cognitive load by allowing students to access information more efficiently without having to search manually. Based on these advantages, qr-codes in this study serve as a link between physical simulation media and digital content, including materials, game instructions, learning videos, and other supporting information.

Hybrid learning media

Hybrid learning media integrates conventional media with digital technology to create a more comprehensive learning experience (Gudoniene et al., 2025). This approach does not replace physical media but rather expands its functionality through information technology, enabling students to gain hands-on learning experiences while accessing digital information quickly. Mulenga & Shilongo (2024) explain that hybrid media can increase learning flexibility because it can be used both online and offline. In this study, the hybrid media concept was realized through the development of PANN, which combines a trading simulation board, commodity cards, transaction cards, and QR codes for access to digital content. This combination allows students to engage in collaborative simulation activities without losing the benefits of digital technology in the learning process.

Simulation method in social studies learning

The simulation method is a learning strategy that provides students with the opportunity to act out specific situations, thereby gaining learning experiences that resemble real-life conditions (Hwang et al., 2022). In social studies, simulations are used to help students understand difficult-to-observe social and economic phenomena through role-playing, decision-making, and problem-solving activities (Paz & Vasconcelos, 2025). The use of simulations encourages active student involvement in the learning process, thereby enhancing conceptual understanding and developing critical thinking, communication, collaboration, and problem-solving skills (Hsu & Wu, 2023). In the inter-island trade material, simulations enable students to play the role of economic actors in the production, distribution, and exchange of goods between regions, helping them understand economic concepts through real-life learning experiences.

The concept of inter-island trade

Inter-island trade is the exchange of goods and services between regions within a country to meet community needs and distribute production from regions with surpluses to those in need (Theresia et al., 2025). This trade activity occurs due to differences in natural resource potential, geographic conditions, production levels, and community needs across regions (Wang, 2022). In the 8th-grade junior high school social studies lesson, the inter-island trade material covers the definition, driving factors, benefits, barriers, distribution of goods, and comparative advantages between regions. The characteristics of this material are dynamic and involve quite complex spatial relationships, requiring learning media that can visually represent the relationships between concepts (Ziatdinov & Valles, 2022). Therefore, the development of simulation media is considered appropriate to help students better understand the mechanisms of inter-island trade.

Method

This research is a research and development (R&D) project that aims to produce PANN (Indonesian trade flow) learning media, based on qr-codes, for students using inter-island trade materials. The developed product is expected to meet three quality criteria, namely valid, practical, and effective, so that it is suitable for use as a social studies learning medium. The research and development approach was chosen because it is not only oriented towards product development but also towards validation, revision, and systematic product testing before implementation in learning.

The ADDIE (analysis, design, development, implementation, and evaluation) model was used, as proposed by Branch (2009). This model was chosen because it has systematic, flexible stages and allows formative evaluation at each stage of development. In the analysis stage, learning needs, student characteristics, inter-island trade material, and learning conditions were analyzed. The design stage included the preparation of media designs, simulation board designs, commodity cards, transaction cards, qr-code integration, digital material development, and research instrument development. The development stage produced an initial media prototype that was subsequently validated by material and media experts. In addition to expert validation, this stage included a focus group discussion (FGD) with social studies teachers as a preliminary evaluation to obtain input on the suitability of the material, media design, linguistic aspects, and potential technical obstacles before the media was implemented. The implementation stage involved field trials with students to assess the practicality of using the media in real-life learning. The final stage, evaluation, was conducted formatively and summatively through analysis of validation results, user responses, and implementation results as a basis for refining the final product.

The research was conducted at SMP Negeri 3 Kabuh, Jombang, East Java. The location was chosen based on the school's characteristics: it is in a suburban area with limited internet access, so learning media that does not rely entirely on a network connection is required. Based on initial observations, the learning of inter-island trade material is still dominated by lecture-based instruction and textbook use, so the concepts of the distribution of goods, comparative advantage, and economic interactions between regions cannot be optimally visualized. This condition makes it difficult for students to understand spatial and dynamic concepts.

The development of PANN media also considers the local potential of Jombang regency, particularly in Kabuh district, which is known for producing agricultural commodities such as sugarcane and corn. The integration of this local potential is

expected to enhance the contextualization of learning, enabling students to more easily connect the concept of inter-island trade with the economic conditions in their immediate environment. Research participants were determined using a purposive sampling technique. Validators consisted of two social studies teachers with experience in learning development and curriculum review. The researcher acted as a practitioner, developing the media and guiding learning during implementation. To maintain the objectivity of observations during the trial, the study also involved a social studies teacher as an independent observer, whose task was to monitor the implementation of learning and student activities using an observation sheet. The trial subjects were 24 eighth-grade students from SMP Negeri 3 Kabuh, selected as representatives of PANN media users.

Research data were collected using a triangulation approach to obtain comprehensive information on media quality. Data collection techniques included expert validation, focus group discussions (FGDs), teacher response questionnaires, student response questionnaires, observation, and documentation. Expert validation was conducted using a four-level Likert-scale validation sheet to assess the suitability of the material content, media design, linguistic aspects, visual appearance, and the technical functionality of the qr-code. Furthermore, FGDs were conducted with social studies teachers during the development stage to obtain input on product weaknesses and alternative improvements before the media was tested in class. After implementation, teachers as practitioners completed a practicality questionnaire to assess the ease of use of the media, the efficiency of learning time, and the clarity of the user guide. Meanwhile, students completed a response questionnaire to determine the ease of use of the media, the attractiveness of the display, the ease of accessing material via qr-code, and the usefulness of the media for understanding inter-island trade material. Observations were conducted during the learning process to collect data on learning implementation and student engagement, while documentation served as supporting data throughout the research process.

Data analysis was conducted using a simple mixed-methods approach, namely descriptive quantitative and qualitative analyses. Quantitative analysis was used to determine the validity and practicality of the media, based on expert validation scores and teacher and student questionnaire responses. The feasibility percentage was calculated using the following formula:

$$\text{Practicality presentation} = \frac{\sum \text{achievement score}}{\sum \text{maximum score}} \times 100\%$$

The calculation results are then interpreted using the eligibility criteria as presented in Table 1.

Table 1 criteria for interpreting the validity and practicality of the product

Percentage (%)	Validity category	Practicality category	Description
76–100	Very high	Very practical	Very suitable (no revision)
51–75	High	Practical	Suitable (minor revision)
26–50	Low	Less practical	Less suitable (major revision)
0–25	Very low	Not practical	Not suitable

Qualitative data obtained from the FGD results, observations, and field notes were analyzed using the interactive analysis model of Miles et al. (2014), which includes three stages: data reduction, data presentation, and conclusion drawing. In the data

reduction stage, all FGD results were transcribed, coded, and selected based on their relevance to media development. The data presentation stage involved grouping validator and observer input into a revision matrix by material, visual design, language, simulation mechanisms, and qr-code functions. Furthermore, in the conclusion-drawing stage, all analysis results served as a basis for refining the prototype until the PANN media met the criteria for validity and practicality for implementation in social studies learning.

Results and discussion

The development of the PANN qr-code media was carried out using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. Each stage produces outputs that serve as the basis for the next stage, ensuring the product meets validity and practicality before being implemented in social studies learning on inter-island trade.

Analysis stage

The analysis phase aims to identify media development needs based on learning conditions, student characteristics, and curriculum demands. Curriculum analysis shows that inter-island trade material in the merdeka curriculum emphasizes not only conceptual mastery but also students' ability to analyze commodity distribution, inter-regional relations, and trade mechanisms contextually. Observations at SMP Negeri 3 Kabuh indicate that the learning process is still dominated by textbooks and lecture methods, resulting in a verbal understanding of the concept of inter-island trade. This situation makes it difficult for students to visualize the process of goods distribution and inter-regional relations. On the other hand, the characteristics of eighth-grade students indicate that they understand the material more easily through visual, collaborative, and experiential learning activities. Although most students have access to smartphones, limited internet access in the school environment prevents the optimal use of fully online media. Environmental analysis also indicates that Kabuh District has local potential for agricultural commodities, particularly sugarcane and corn. This potential has not been utilized as a context for social studies learning, thereby providing the basis for developing PANN media that integrate local commodities with qr-code-based inter-island trade simulations.

Design stage

Based on the needs analysis results, an initial design for the PANN media (Prototype I) was developed. This stage resulted in a simulation board design in the form of a simplified map of Indonesia, focusing students' attention on commodity distribution channels. Furthermore, a role-playing game mechanism was developed that allows students to act as inter-regional distribution actors using commodity cards, transaction cards, and logistics pawns. This stage also included qr-code integration as a link between physical media and digital content. qr-codes were placed on the simulation board to provide students with access to learning videos, inter-island trade case studies, and supporting information relevant to the simulation activities.

Development stage

The development phase resulted in PANN media in physical and digital formats ready for validation. The development process used canva to design the game board,

commodity cards, transaction cards, and student worksheets. Once the designs were complete, qr-codes were integrated into the media to access supporting digital content.



Figure 1 qr-code video of inter-island trade



Figure 2 export commodities of Jombang regency



Figure 3 PANN simulation media

Figure 1 shows a qr-code linked to a learning video about inter-island trade mechanisms. This video is an additional learning resource students can access before and during the simulation activity. Figure 2 displays commodity cards developed based on the local potential of Jombang regency, namely sugar cane and corn. The use of local commodities aims to increase the contextual relevance of learning, so students can more easily connect trade concepts to real-world conditions in their surroundings. Figure 3 shows the final appearance of the PANN simulation board used in the learning activity.

The media includes a map of Indonesia, commodity cards, distribution plans, and a qr-code that links to digital learning resources. Next, the media was validated by two validators: a material expert and a media expert. The validation results are presented in Table 2.

Table 2 results of expert validation of PANN media

Nu.	Categories and aspects of feasibility assessment	Σ Achievement score	Σ Maximum score	Achievement (%)	Eligibility
1.	Subject matter expert eligibility				
	a. Conformity to learning outcomes	7	8	87.50	Very high
	b. Accuracy of spatial trade concepts (economics)	8	8	100.0	Very high
	c. Contextuality of local commodities (sugarcane/corn)	8	8	100.0	Very high
	d. Quality of case study narratives in the student worksheet	7	8	87.5	Very high
2.	Media expert eligibility				
	a. Clarity of layout (presentation design)	7	8	87.5	Very high
	b. Ergonomics of detachable components	8	8	100	Very high
	c. Physical durability of media components	6	8	75	High
	d. Technical functionality of qr-code links	8	8	100	Very high
Average		59	64	92.18	Very high

Source: primary data, processed

Based on Table 2, the expert validation results show that the PANN media achieved a very high level of feasibility, with a total score of 59 out of a maximum of 64, or an average percentage of 92.18%, and was declared very suitable for use in learning. In terms of material feasibility, all indicators obtained a very high category, including conformity to learning outcomes of 87.50%, accuracy of spatial trade concepts (economics) of 100%, contextuality of local commodities (sugarcane/corn) of 100%, and the quality of the narrative of case studies in the student worksheet of 87.50%. These results indicate that the material presented is in accordance with the learning objectives, has good conceptual accuracy, integrates local contexts effectively, and is supported by high-quality case studies. Meanwhile, in the aspect of media feasibility, the layout clarity indicator obtained a percentage of 87.50% with a very high category, the ergonomics of detachable components reached 100% with a very high category, the physical durability of media components obtained 75% with a high category, and the technical functionality of the qr-code link reached 100% with a very high category. Although the physical durability aspect is still in the high category and has a lower value than other indicators, overall, the validation results show that PANN media meets the feasibility criteria for both materials and media, making it suitable for use as a learning medium.

In addition to quantitative validation, the development process also obtained input through focus group discussions (FGD) with social studies teachers.

Table 3 FGD results and product revisions

Main code	Excerpt from the FGD transcript of allied teachers	Researcher's corrective action (revision)
Physical material revision	"Eighth-grade students' tendency to be motorically active puts them at risk of quickly damaging thin media components. It would be better to increase the thickness of the cardstock."	Replaced the commodity card printing material with 260 gsm art carton paper with a double laminate for greater sturdiness and durability.
Language and content revision	"There was a conceptual bias in the initial draft of the student worksheet, which included the term 'exports and international trade.' The wording should be adjusted to reflect the learning outcomes."	Changed the overall wording of the written instructions for the student worksheet strictly to "inter-island trade" or "inter-regional commodity distribution" in accordance with the Grade VIII target material.
Digital design revision	"The qr-code position on the initial draft of the map image was too small, making it difficult for students' smartphone cameras to detect the autofocus point from the group's reading distance."	Enlarged the qr-code dimensions to a realistic 5x5 cm and moved them to the corners of the main map for better ergonomic scanning.

Source: primary data, processed

Based on Table 3, the FGD with teachers from the same school yielded several important insights that served as the basis for improving the PANN media product before its implementation. Regarding revisions to the physical materials, the teacher noted that the characteristics of eighth-grade students, who tend to be motorically active, could make the thin media components more prone to damage. Following up on this input, the researcher replaced the commodity card material with 260 gsm art carton paper, double-laminated to increase the media's strength and durability. In terms of language and content revision, the term "export and international trade" in the initial draft of the student worksheet was found to be inappropriate for the learning outcomes of eighth-grade students. Therefore, the researcher revised all wording to the terms "inter-island trade" or "inter-regional commodity distribution" to align with the scope of the material set out in the curriculum. Furthermore, regarding the digital design, the teacher noted that the qr-code on the map was too small, making it difficult to scan with students' devices. As a follow-up, the researchers enlarged the qr-code to 5 × 5 cm and placed it in the corner of the main map to make scanning easier and more ergonomic for group learning. Overall, the FGD results showed that teacher input focused not only on improving the physical quality of the media but also on content accuracy and ease of use, ensuring the final product was better aligned with student characteristics, curriculum demands, and classroom implementation needs.

Implementation stage

Prototype II was implemented in eighth-grade social studies learning involving 24 students. The implementation aimed to determine the level of practicality of the media based on teacher and student responses after its use in learning. Based on Table 4, the results of the PANN media practicality test indicate that the media have a very high level of practicality, as assessed by practitioners and students. The assessment from practitioners consisting of two social studies teachers obtained a total score of 30 out of a maximum score of 32, with an achievement of 93.75%, which is included in the very practical category, indicating that the media is easy to use, according to learning needs,

and effective to be implemented in the classroom. Meanwhile, the assessment of 24 grade VIII students yielded a score of 351 out of a maximum of 384, with an achievement of 91.40%, which also falls within the very practical category, indicating that the media is easy to understand, interesting, and helps the learning process both independently and in groups. Overall, the average practicality test results were 190.5 out of 208, achieving 91.58%, indicating that the PANN media is considered very practical because it is easy to use, highly applicable, and receives positive responses from both teachers and students during the learning process.

Table 4 results of the PANN media practicality test

Nu.	Respondent group	Total score	Maximum score	Achievement	Practicality
1	Practitioners (2 social studies teachers)	30	32	93.75%	Very practical
2	Students (24 eighth-grade students)	351	384	91.40%	Very practical
Average		190.5	208	91.58%	Very practical

Source: primary data, processed

Observations showed that all students were actively involved in the simulation. Learning activities took place collaboratively, with roles divided among distributors, logistics couriers, and digital information managers. Minor obstacles, such as initial difficulties scanning qr-codes, were overcome through student collaboration without disrupting the learning process.



Figure 4 learning using PANN media



Figure 5 students analyze Jombang commodities



Figure 6 simulation of inter-island trade using PANN

Figures 4–6 demonstrate the implementation of PANN media in social studies learning, which is active, interactive, and student-centered. Figure 4 demonstrates the learning process using PANN media as the primary means of delivering material, making learning more contextual and engaging. Furthermore, Figure 5 shows students engaged in a commodity analysis activity in the Jombang region, identifying local commodities and linking them to the concepts of distribution and regional economic potential. This activity demonstrates strong cognitive engagement, as students not only receive information but also process and interpret the data directly. Meanwhile, Figure 6 shows an inter-island trade simulation using PANN media, where students actively participate in simple economic interactions through role-playing or simulations. This activity not only fosters understanding of interregional trade concepts but also develops collaboration, communication, and decision-making skills. Overall, this series of activities demonstrates that PANN media can create meaningful, context-based learning and encourage active student participation in understanding social studies concepts more concretely.

Evaluation stage

The final stage in the ADDIE model includes an evaluation process consisting of formative and summative evaluations, which serve as the basis for determining the product's final feasibility. Formative evaluations are carried out at each stage of the development process and used to improve the quality of the media, based on input from experts through FGDs. The results of this evaluation indicate several important revisions, including improving the physical quality of the media through the use of thicker commodity card paper to increase durability, realigning the wording of terms in the student worksheet to align with learning outcomes and the appropriate context of economic material for students, and improving the digital design by enlarging the size of the qr-code to make it easier to scan and increase accessibility to use the media in the classroom. Meanwhile, a comprehensive summative evaluation is conducted at the end of development to assess the product's overall feasibility using quantitative data from various sources. The combined results indicate that the PANN media received 92.18% expert validation, 93.75% teacher practicality, and 91.40% student practicality. Based on these results, it can be concluded that the qr-code-based PANN Simulation hybrid media has a very high level of feasibility, making it a highly effective alternative social studies learning tool at the secondary school level.

Discussion

The results of the study indicate that the qr-code-based PANN Simulation learning media achieved validity of 92.18% (very high) and practicality of 91.58% (very practical). These findings confirm that the developed media is suitable for use in social studies learning, especially on the Inter-Island Trade material in grade VIII of junior high school. The high validity indicates that the material, media design, and technology integration aspects align with the learning outcomes of the merdeka curriculum. Meanwhile, the high practicality indicates that the media can be implemented effectively in the classroom without requiring complex technical skills or high digital infrastructure. Thus, PANN media can be seen as a hybrid learning innovation that addresses the needs of schools with limited internet access.

This success can be explained through the perspectives of dual coding theory (Paivio, 2014) and cognitive theory of multimedia learning (Mayer, 2021). From a dual coding perspective, learning outcomes are more optimal when information is processed through two channels simultaneously: verbal and visual. In the implementation of PANN media, verbal stimuli in the form of student worksheet narratives, game instructions, and explanations of economic concepts are combined with visual stimuli in the form of maps of Indonesia, commodity cards, and the movement of logistics pawns. The integration of these two forms of representation allows students to build stronger conceptual connections between abstract economic theory and the real-life simulations they conduct in class. This strengthens the process of encoding information into long-term memory, making the concept of inter-island trade easier to understand and remember.

Furthermore, based on the cognitive theory of multimedia learning, the effectiveness of multimedia learning is determined by the media's ability to manage students' cognitive load through the principles of dual-channel processing, limited capacity, and active processing. In this study, the use of qr-codes for selective access to digital materials serves as a cognitive load management strategy. Information is not presented excessively in a single visual space but is separated across physical media (maps and game cards) and digital media (learning videos accessed via qr-codes). This strategy aligns with the principles of coherence and segmentation in Mayer's (2021) theory, which holds that structuring information can reduce the risk of cognitive overload. Thus, students can focus on one cognitive activity at a time, thereby optimizing comprehension.

In addition to cognitive aspects, the effectiveness of PANN media is also strengthened by game-based learning and contextual teaching and learning (CTL) approaches. Through game-based simulation designs, students are actively engaged in competitive and collaborative learning activities. They act as distributors in the inter-island trade system, so learning is no longer passive but rather based on direct experience (experiential learning). This game mechanism has been proven to increase student engagement, as found in research by Sierra & Collado (2022); Novaes (2026), which showed that trade simulations can significantly increase motivation and understanding of economic concepts by providing learning experiences that mimic socioeconomic realities.

The CTL approach in PANN media is strengthened through the integration of the local context of Jombang Regency, specifically sugarcane and corn commodities. This integration serves as a contextual anchor, connecting the abstract concept of inter-island trade to students' realities. When students move logistics pawns between regions in the simulation, they indirectly practice economic concepts such as the distribution of goods,

opportunity costs, and regional surpluses and deficits. This aligns with research by Fitrianto & Farisi (2025), which found that integrating local wisdom into social studies learning can strengthen connections between academic concepts and students' real-life experiences, resulting in more meaningful learning.

The findings of this study also support the research results of Hernando & Macías (2023); Widanti & Fathurrahman (2024); Rakha (2025); Lusiani et al. (2026); Petkovic et al. (2026), which show that the use of qr-codes in learning media can increase learning independence, efficiency of information access, and reduce students' cognitive load. However, unlike previous studies, which generally integrate qr-codes only as a medium for accessing materials, this study develops a more comprehensive approach by integrating physical simulations, role-playing, and interactive digital content into a hybrid learning system. Thus, the novelty of this study lies in the combination of three main elements: game-based physical media, qr-code technology as a digital bridge, and the local context of inter-island trade as a source of learning experiences. Overall, the results of this study indicate that PANN media not only meet the criteria of validity and practicality but also have strong potential to improve the quality of social studies learning through a more interactive, contextual, and experience-based approach. The transformation of learning from verbalistic patterns to simulation-based learning demonstrates that this medium can create a more lively, collaborative, and meaningful learning environment for grade VIII junior high school students.

Conclusions

This research resulted in a qr-code-based PANN simulation learning media product for eighth-grade junior high school students. Based on the validity test conducted by material and media experts, this media received an average score of 92.18% (very high). Meanwhile, the practicality test showed a practicality level of 91.58% (very practical) based on teacher and student responses. These findings indicate that PANN media is suitable for use in social studies learning because it effectively integrates physical and digital media and facilitates more interactive, contextual, and meaningful learning.

The implications of this research indicate that hybrid simulation and qr-code-based learning media can serve as an innovative alternative in social studies learning, particularly for abstract material that requires spatial visualization, such as inter-island trade. PANN media not only increases student engagement in the learning process but also supports the implementation of meaningful learning, game-based learning, and contextual teaching and learning approaches. Thus, this research provides practical contributions to teachers in developing learning media that adapt to limitations of the digital infrastructure, while also supporting the implementation of the merdeka curriculum, which emphasizes active, student-centered learning.

This research has several limitations. Among them, the learning effectiveness test was not conducted experimentally with a strict control design, and the study subjects were limited to a single class with a relatively small number of students. Furthermore, long-term testing of learning outcomes and concept retention was not conducted in depth. Therefore, further research is recommended to conduct effectiveness tests using a quasi-experimental design with a larger sample size, as well as to evaluate the long-term impact of PANN media on students' learning outcomes, critical thinking skills, and economic literacy. Further development can also focus on integrating more adaptive technologies, such as interactive digital platforms based on learning analytics.

References

- Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer Science & Business Media.
- Damayanti, I., & Sukirno, S. (2025). PowerPoint learning media to improve activeness and learning outcomes in the Economics subject. *Curricula: Journal of Curriculum Development*, 4(1), 357–368. <https://ejournal-education.upi.edu/curricula/article/view/459>
- Fitrianto, I., & Farisi, M. (2025). Integrating Local Wisdom into 21st Century Skills: A Contextual Framework for Culturally Relevant Pedagogy in Rural Classrooms. *International Journal of Post Axial: Futuristic Teaching and Learning*, 3(2), 109–121. <https://doi.org/10.59944/postaxial.v3i2.444>
- Gudoniene, D., Staneviciene, E., Huet, I., Dickel, J., Dieng, D., Degroote, J., Rocio, V., Butkiene, R., & Casanova, D. (2025). Hybrid Teaching and Learning in Higher Education: A Systematic Literature Review. *Sustainability*, 17(2), 756. <https://doi.org/10.3390/su17020756>
- Hernando, R., & Macías, J. A. (2023). Development of usable applications featuring QR codes for enhancing interaction and acceptance: a case study. *Behaviour & Information Technology*, 42(4), 360–378. <https://doi.org/10.1080/0144929X.2021.2022209>
- Hsu, C.-Y., & Wu, T.-T. (2023). Application of Business Simulation Games in Flipped Classrooms to Facilitate Student Engagement and Higher-Order Thinking Skills for Sustainable Learning Practices. *Sustainability*, 15(24), 16867. <https://doi.org/10.3390/su152416867>
- Hwang, G., Chang, C., & Chien, S. (2022). A motivational model-based virtual reality approach to prompting learners' sense of presence, learning achievements, and higher-order thinking in professional safety training. *British Journal of Educational Technology*, 53(5), 1343–1360. <https://doi.org/10.1111/bjet.13196>
- Ibrahim, I., Nurwahidah, N., Suranti, N. M. Y., & Alimuddin, N. (2025). Integrating QR Code Technology in Elementary Science Content: A Developmental Study on Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, 11(11), 215–228. <https://doi.org/10.29303/jppipa.v11i11.12629>
- Langoday, Y. R., Nurrahma, N., & Rijal, S. (2024). Policy Reflection: Kurikulum Merdeka as Educational Innovation in the Era of Society 5.0. *Edunesia: Jurnal Ilmiah Pendidikan*, 5(2), 957–978. <https://doi.org/10.51276/edu.v5i2.915>
- Leshchenko, T., Zhovnir, M., Shevchenko, O., & Grinko, N. (2022). The usage of quick response codes: evolution and integration in classroom activities in the context of language learning. *ScienceRise: Pedagogical Education*, 4(49), 52–58. <https://doi.org/10.15587/2519-4984.2022.261828>
- Lusiani, L., Vidhiasi, D. M., & Supriyanto, S. (2026). The Implementation of a Deep Learning Approach Using QR Code-Based Learning Media to Enhance High School Students' Academic Performance in Kinematics. *Jurnal Penelitian Pendidikan IPA*, 12(1), 521–536. <https://doi.org/10.29303/jppipa.v12i1.13484>
- Mayer, R. E. (2021). *The Cambridge handbook of multimedia learning* (3rd ed.). Cambridge University Press.
- Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative Data Analysis* (3rd ed.). SAGE Publications.
- Morris, D. L. (2025). Rethinking Science Education Practices: Shifting from Investigation-Centric to Comprehensive Inquiry-Based Instruction. *Education Sciences*, 15(1), 73. <https://doi.org/10.3390/educsci15010073>

- Mulenga, R., & Shilongo, H. (2024). Hybrid and Blended Learning Models: Innovations, Challenges, and Future Directions in Education. *Acta Pedagogica Asiana*, 4(1), 1–13. <https://doi.org/10.53623/apga.v4i1.495>
- Novaes, A. L. (2026). Enhancing sustainability education in higher education through simulation-based learning: integrating sustainable development goals. *International Journal of Sustainability in Higher Education*, 27(5), 1124–1141. <https://doi.org/10.1108/IJSHE-08-2024-0571>
- Paivio, A. (2014). *Mind and its evolution: A dual coding theoretical approach*. Psychology Press.
- Paz, M., & Vasconcelos, C. (2025). Scientific Literacy to Address Sustainability: A Study on Deep-Sea Mining Education with Adolescents from a Social Care Institution. *Sustainability*, 17(2), 688. <https://doi.org/10.3390/su17020688>
- Petkovic, Z., Nanu, L., & Mistry, T. (2026). Unlocking loyalty: How digital ease of use shapes memorable experiences and satisfaction for older adults in hospitality. *Journal of Hospitality and Tourism Insights*, 1–21. <https://doi.org/10.1108/JHTI-10-2025-1223>
- Rakha, A. H. (2025). Cooperative learning with QR codes technology: enhancing cognitive achievement and attitudes among students. *Frontiers in Education*, 10. <https://doi.org/10.3389/feduc.2025.1655913>
- Rosbina, A., Wardani, S., & Haryono, H. (2025). Development of Web-Based Learning Media with an Inquiry Model to Enhance Learning Outcomes and Student Independence in Elementary Schools. *Journal of Innovation and Research in Primary Education*, 4(3), 673–683. <https://doi.org/10.56916/jirpe.v4i3.1354>
- Sexton, S. S. (2025). Meaningful Learning—David P. Ausubel. In *Science Education in Theory and Practice* (pp. 157–171). https://doi.org/10.1007/978-3-031-81351-1_10
- Sierra, J., & Collado, Á. S. (2022). Wealth and power: Simulating global economic interactions in an online environment. *The International Journal of Management Education*, 20(2), 100629. <https://doi.org/10.1016/j.ijme.2022.100629>
- Suari, S., Indrawadi, J., & Syahriani, F. (2024). Exploration of learning strategies in the social studies based on the Merdeka Curriculum. *Al-Ta Lim Journal*, 30(2), 195–210. <https://doi.org/10.15548/jt.v30i2.920>
- Syaadah, R. S., Paristiowati, M., Astuti, T. N., Hanifah, S., Salsabila, D., Agustin, F. S., & Alia, A. R. (2025). Development of an Interactive Learning Website Using a Deep Learning Approach on Thermodynamics Material. *Journal of Physics: Conference Series*, 3139(1), 012090. <https://doi.org/10.1088/1742-6596/3139/1/012090>
- Theresia, A., Ikhsan, M., Kacaribu, F. N., & Sumarto, S. (2025). Spillover Effect of Food Producer Price Volatility in Indonesia. *Economies*, 13(9), 256. <https://doi.org/10.3390/economies13090256>
- Wang, X. (2022). Managing Land Carrying Capacity: Key to Achieving Sustainable Production Systems for Food Security. *Land*, 11(4), 484. <https://doi.org/10.3390/land11040484>
- Widanti, A. P., & Fathurrahman, M. (2024). Development of Digital Learning Materials Using a QR Code Based Book Creator Application to Improve Student Learning Outcomes in Science Subjects. *Jurnal Penelitian Pendidikan IPA*, 10(10), 7885–7893. <https://doi.org/10.29303/jppipa.v10i10.7933>
- Yunita, M., Driana, E., Yuliawati, S., & Ernawati, E. (2025). Project-Based Integrated Science Learning for Developing Students' Creative Thinking Skills: A Case Study at a Madrasah Tsanawiyah in Sukabumi City. *Jurnal Penelitian Pendidikan IPA*,

11(4), 724–735. <https://doi.org/10.29303/jppipa.v11i4.10919>
Ziatdinov, R., & Valles, J. R. (2022). Synthesis of Modeling, Visualization, and Programming in GeoGebra as an Effective Approach for Teaching and Learning STEM Topics. *Mathematics*, 10(3), 398. <https://doi.org/10.3390/math10030398>