

Improving students' self-directed learning through visual novel games developed by Ren'Py application

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Abstract

The Merdeka Curriculum introduces Natural and Social Science (NSP)/ Ilmu Pengetahuan Alam dan Sosial (IPAS) subjects to improve science literacy among primary school students. However, in one of the public elementary schools in Semarang, teachers still dominantly use the lecture method and textbooks, causing the science understanding of class 5A students in the 2023/2024 school year to remain low, as seen from the unsatisfactory results of daily tests and STS. This study aims to develop learning media through IPAS-based visual novel educational games with a Development Research approach using the ADDIE method and a one-group pretest-posttest research design. The sample consisted of 30 students from class 5A who were selected by purposive sampling. The game media was developed using the Ren'Py application and validated by media and material experts. The validation results showed the game had a very high level of validity. The effectiveness test showed increased self-directed learning with an N-Gain value of 0.73, indicating that the game is quite effective. The visual novel game 'Earth and Environment' is expected to help teachers overcome the limitations of digital media in IPAS learning and improve students' self-directed learning ability.

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INTRODUCTION

The Merdeka Curriculum was developed to mitigate learning loss intensified by the Covid-19 pandemic, during which students experienced a decline in learning independence and motivation in online learning environments (Sari *et al.*, 2023; Maba *et al.*, 2023). Research indicates that Indonesian students' literacy and science proficiency remain low, as reflected in national and international assessments (Parahita *et al.*, 2023). Given the increasing complexity of 21st-century global challenges, the OECD underscores the importance of science literacy in preparing students for the demands of the modern world.

As a member of the Organisation for Economic Co-operation and Development (OECD), Indonesia participates in the Programme for International Student Assessment (PISA), which evaluates the literacy, mathematics, and science competencies of 15-year-old students (Sudrajat *et al.*, 2023). However, the 2022 PISA results revealed a decline in Indonesia's performance compared to 2018, with reading scores dropping from 371 to 359, mathematics from 379 to 366, and science from 396 to 383 (OECD, 2023). These results are comparable to scores from two decades ago, highlighting the stagnation of educational progress since 2000 (Ismawati *et al.*, 2023). The OECD has identified science literacy as a fundamental competency for the 21st century, emphasising that strengthening students' skills in science, reading, and mathematics—both inside and outside the classroom—is essential for educational advancement.

In response to PISA 2018 findings and the educational setbacks caused by the pandemic, the Merdeka Curriculum was introduced as a means of revitalizing education (Ariesanti *et al.*, 2023; Sudrajat *et al.*, 2023). A key reform within this curriculum is the integration of science and

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social studies into Natural and Social Sciences (IPAS), a subject designed to enhance students' understanding of human-environment interactions while fostering competencies outlined in the Pancasila Learner Profile (Fitriyah & Wardani, 2022). IPAS equips students with essential problem-solving skills, critical thinking, and scientific reasoning by incorporating multidisciplinary perspectives, aligning with OECD's recommendations for preparing students to navigate 21st-century global challenges (Agustina *et al.*, 2022).

IPAS is introduced from grades 3 to 6 at the primary school level, with learning outcomes (CP) structured into three phases (Sahrandi & Bahri, 2023). The Merdeka Curriculum encourages teachers to implement engaging, interactive, and practical learning approaches, although adapting to these pedagogical changes requires time and effort (Rahmayati & Prastowo, 2023). Ensuring both teachers and students master IPAS concepts is crucial, as scientific literacy serves as a foundation for developing the skills necessary to face future challenges in an increasingly complex world.

Regarding the importance of IPAS, self-directed learning (SDL) is a highly relevant approach that significantly contributes to supporting students in achieving proficiency in IPAS. Knowles (1975) stated that SDL is the process by which individuals take responsibility for their own learning. In the age of information technology, these skills are essential not only during the Covid-19 outbreak, when most learning was remotely but also in preparing students for future challenges (Febry *et al.*, 2019). Moreover, introducing SDL in primary school enables students to identify their learning needs, manage their time, and evaluate their progress. Research has shown that implementing SDL in primary school students effectively enhances motivation and learning outcomes (Trisiana *et al.*, 2023). Additionally, visual novel educational games can promote self-learning awareness, positively influencing academic performance and long-term success.

Furthermore, the digital era of the 21st century presents significant opportunities for enhancing science literacy through digital media. Integrating digital media in the learning process is essential for improving student interaction and comprehension (Ibda *et al.*, 2023). However, many teachers continue to rely on traditional methods despite the increasing availability of digital technology (Wayan Kandia *et al.*, 2023). Teachers must adapt to technological advancements to effectively implement the Merdeka Curriculum, which aligns with Industry 4.0 (Astutik & Yuhastina, 2022). However, the development of digital-based learning media for IPAS subjects remains limited, as IPAS is a relatively new subject requiring a contextual approach (Budiwati *et al.*, 2023; Prahani *et al.*, 2023). Nevertheless, digital media has the potential to facilitate a deeper understanding of science concepts in IPAS while also enhancing students' motivation to learn (Khaira & Mustika, 2024; Listiana *et al.*, 2024).

One of the promoted digital media is digital-based educational games, which are classified as serious games and are becoming a popular interactive medium in education today. Educational games aim to not only provide entertainment but also improve students' skills and competencies through fun interactions (El Arroum *et al.*, 2020; Delcker & Ifenthaler, 2020). The games incorporate visual and audio elements that enhance students' thinking and imagination (Wahidah *et al.*, 2020). One compelling educational game genre is the visual novel, which presents an interactive story with various multimedia elements, such as text, visual illustrations, and music, to create an immersive learning experience (Khrisna *et al.*, 2023).

Research indicates that visual novel games effectively enhance students' learning motivation and comprehension across various subjects, including English and biology (Prasetyo & Kuswardani, 2021; Tsong Chau & Nasir, 2021). This genre holds significant potential for teaching IPAS (Science, Technology, and Society), as it can transform abstract concepts into engaging narratives that are easier for students to understand (Khoiruddin *et al.*, 2023). The selection of visual novel educational games is further supported by the widespread accessibility of devices, particularly Android smartphones, which Indonesian children increasingly use. By 2022, 40.25% of children under 15 had access to a smartphone (BPS, 2022). While smartphone usage primarily

serves entertainment and social media purposes, this trend raises concerns about its potential negative impact on children's development (Marhaeni *et al.*, 2023). Given this rise in smartphone usage and Indonesia's low science literacy, there is a pressing need to promote self-learning awareness in primary school (Trisiana *et al.*, 2023).

Initial observations and interviews at a public primary school in Semarang revealed that the school has been implementing the Merdeka Curriculum for two years, particularly in Natural and Social Sciences for Phase B and C students. Additionally, according to one of the grade 5 teachers, students' interest in reading theoretical Natural and Social Science materials tends to be low. The average daily test score of students in class 5A was 62.55, while their midterm summative score (STS) was 63.15. The homeroom teacher evaluated these results as suboptimal, as students' understanding of Natural and Social Sciences (NSP) content remained low, possibly due to their reliance on monotonous and less interactive textbooks. This school is suitable for the study to delve into the potential contribution of a visual novel game in enhancing students' self-directed learning.

Based on the previous discussion, this study develops a visual novel game to support students' self-directed learning in mastering IPAS subjects at the elementary school level. While limited research has been conducted on visual novel-based educational games for IPAS learning, this study seeks to bridge that gap and contribute to understanding the effectiveness of using learning media to support students' self-directed learning. The results of this study will enrich both previous and existing research on the broad topics of Merdeka curriculum implementation, natural and social science subjects, and game-supported learning, both theoretically and practically.

LITERATURE REVIEW

Research by Nusantara *et al.* (2023) showed that visual novel-based educational games effectively improve elementary school students' reading skills using the Ren'py application and the ADDIE approach. Galindra *et al.* (2023) and Abdillah *et al.* (2023) highlight the benefits of using visual novels in learning, with the ADDIE approach to improve learning outcomes. Research from Øygardslia *et al.* (2020) provides the design principles of visual novel educational games, such as material accessibility, engaging storylines, and in-depth characters. Other research, such as Prakoso & Arifianti (2021) and Lovita & Herlina (2023), also confirmed the effectiveness of visual novels in increasing students' motivation and self-learning ability, especially in the context of Natural and Social Sciences (NSP) subjects. Pacheco (2024) added that educational games can encourage self-learning abilities and create a safe learning environment for students to experiment and learn from their mistakes. The following is an explanation of the theoretical basis used in this research.

First, learning media. Learning media consists of two words: 'media' and 'learning.' 'Media' comes from the Latin *medius*, which means intermediary, and is a tool used to convey messages or information. According to the Association for Educational Technology in Suryani *et al.* (2018, 2), media includes all forms and channels of communication used to deliver messages. "Learning" is the interaction between teachers and learners to achieve educational goals, including developing thinking skills, emotional management, and socialization (Sanaky, 2013). In education, media can be objects, people, or events supporting teaching and learning. Learning media are tools used to convey instructional information to support teaching. Using varied learning media helps create a more interactive and practical learning experience (Arsyad, 2015, 4).

The term "game" has a broad meaning that encompasses activities for entertainment, both physical and mental, often voluntary and involving competition between players (Kalmpourtzis, 2018, 69; Parisa *et al.*, 2023). With the advancement of technology, games evolved into "video games", which incorporate digital interactivity through electronic devices such as consoles, computers, or smartphones and are used for entertainment, education, and sports. (Adžić *et al.*, 2021).

In the beginning, games only served as entertainment, but now they have evolved into educational games that support learning through interactive approaches, such as game-based learning (Adipat *et al.*, 2021; Dimitra *et al.*, 2020). Effective educational game design should integrate the principles of interactivity, immersiveness, problem-solving, feedback and exploration to increase student motivation to learn (Kucher, 2021). One of the game genres is the visual novel. Visual novels, a popular game genre with interactive narratives, have been used in education because they allow players to make decisions that affect the storyline, increasing student interest and engagement (Camingue *et al.*, 2021; Lynch *et al.*, 2019).

Second, natural sciences (IPA) and social sciences (IPS). The Merdeka Curriculum introduces the subjects of Natural and Social Sciences (IPAS) because of the integration of Natural Sciences (IPA) and Social Sciences (IPS), which are adapted to the cognitive characteristics of elementary school students who still think holistically and (Purnawanto, 2022). This subject aims to understand the relationship between natural and social phenomena thoroughly. The approach is student-centred, where the teacher acts as a facilitator who creates interactive and contextual learning spaces and encourages active student participation (Marwa *et al.*, 2023).

Third, self-directed learning (SDL). Self-directed learning is a learning process that is planned and controlled by individuals, where they actively determine their needs, goals, resources, and evaluation of learning outcomes (Knowles, 1975). Gibbons (2003:2) adds that this ability allows individuals to improve knowledge and skills through personal initiative, with flexibility in methods, time and situations. Self-directed learning is important in deepening understanding and developing essential skills such as time management, study strategies, and problem-solving. Although it is more often associated with adult learners due to their intrinsic motivation and experience (Robinson & Persky, 2020), children also have the potential to develop these abilities through the support of a conducive learning environment (Sugerman *et al.*, 2022).

METHOD

The research method applied in this study is Development Research, defined by Mills & Gay (2018, 17) As a series of systematic activities to create and improve educational products. This research not only produces innovations but also systematically evaluates the effectiveness and usefulness of the product in its context of use, using the ADDIE model as a development framework. As described by Branch (2009), this model is a systematic instructional design to create effective teaching materials.

This study was conducted in one of the public elementary schools in Semarang, Central Java, with a population of thirty students ($n=30$) in class 5A from January 11 to May 31, 2024. The Earth and Environment topic from chapter 8 of the IPAS subject was selected as the basis for developing a visual novel-based educational game. This material is relevant for preparing students for the End of Semester Summative Assessment (SAS) and is important for understanding complex environmental issues. Ren'Py app has been used as an application to develop the visual novel game combined with other apps.

To assess the quality of the game, this study uses a purposive sampling technique, as described by Creswell (2009, 145). This method was chosen to select participants to ensure the data obtained is relevant and rich. Data on the needs of students and teachers were collected through interviews, observations, and documentation. A Likert scale questionnaire was used in a one-group pretest-post-test research design to evaluate the effectiveness of the media. Validity and reliability tests were conducted using the product-moment correlation formula and Cronbach's alpha. Descriptive quantitative data analysis was employed to evaluate the effectiveness of the visual novel educational game media in enhancing students' self-directed learning abilities by measuring the increase in self-directed learning through a gain normality test before and after using the media in IPAS learning.

RESULT AND DISCUSSION

The development process uses the ADDIE model reference, which starts from the needs analysis stage to the final evaluation. The research results obtained at each stage will be described in detail in the following discussion.

A. Analyze phase

Due to several factors, the IPAS subject, part of the Merdeka curriculum, was chosen to develop the educational visual novel game. *First*, teachers still rely on conventional media, such as government-issued textbooks, as IPAS is relatively new (Khaira & Mustika, 2024). *Second*, science literacy among Indonesian elementary students is low, with IPAS not benefiting from interactive media like educational games. This is reflected in the OECD's (2023) PISA results, showing below-average science literacy with slight improvement in recent years. Additionally, daily and midterm test scores from grade 5 students in Semarang in the 2023/2024 school year indicate unsatisfactory results, highlighting the need for better science literacy efforts. Contributing factors include students' overuse of smartphones for entertainment, reducing their focus on learning and hindering independent learning development. The limited variety of interactive media in IPAS lessons also diminishes student engagement (Khaira & Mustika, 2024). Thus, there is a clear need for learning media that supports IPAS learning while fostering self-directed learning skills.

Research by Listiana *et al.* (2024) suggests that interactive digital media, such as educational games, can help elementary students grasp abstract IPAS concepts that are difficult to understand without proper visualisation. These games also support independent learning, tailored to students' abilities and interests. Observations show that many grade 5 students enjoy smartphone-accessible games, typically for entertainment. Unlike these leisure games, the educational game developed in this study is a serious game, designed not only for entertainment but also for learning, as outlined by El Arroum *et al.* (2020). The visual novel genre used in this study is particularly effective for elementary students (Abdullah *et al.*, 2023). It offers the advantage of engaging students through fun and easy-to-understand content delivered via character dialogues (Prakoso & Arifianti, 2021). Thus, visual novel-based educational games present an innovative solution to overcome challenges in teaching IPAS material.

B. Design phase

The next stage is the design or planning stage. At this stage, researchers developed a design framework for a visual novel-based educational game. This design stage aims to produce a structured and effective learning media design. The design stage begins with creating competency maps and material maps, which serve as visual representations to illustrate the relationship between topics and the level of competence that students are expected to achieve after the learning process. These two maps were developed based on the material "Earth and Environment" found in Chapter 8 of the IPAS grade 5 official book released by the Indonesian Ministry of Education, which examines the impact of human activities on Earth changes. The subtopics described include the causes of earth changes, the reasons behind environmental damage due to human activities, and the impact and preventive efforts that can be made.

After determining the primary material, the next step is to develop the media framework using a flowchart. In developing visual novel-based learning media, the flowchart acts as a structured guide from the beginning to the end of the game. Based on the flowchart design, this visual novel educational game has four menus with different functions and features: the main menu, game start menu, story start menu and pause menu. The next planning process involves preparing the material description and the Media Content Outline (GBIM).

The material description refers to the documentation or detailed description of the subject matter presented through the media. Meanwhile, the GBIM acts as an initial design that presents an overview of the content and structure of the media being developed, making it easier to un-

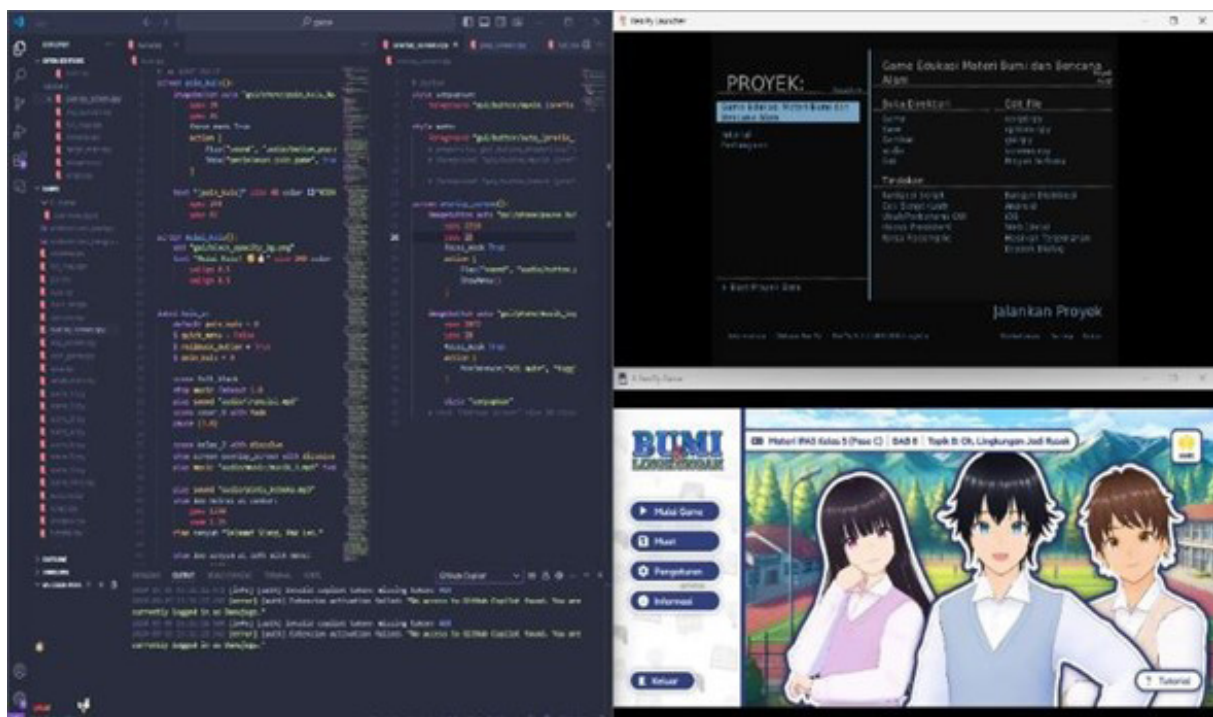
derstand and deliver the material effectively. A media script design is needed as a reference that directs the production process of each scene displayed in the visual novel. This script includes various components, including display descriptions such as navigation buttons and text, audio used, and descriptions of animations or videos displayed. Each element is explained in detail to ensure the visual novel media adequately conveys the message or material to students. In addition, researchers also compiled a framework of Learner Worksheets (LKPD) designed as a guide and means of integration in the learning process through visual novel-based educational game media. The framework of this LKPD is intended to guide learners in completing practice questions gradually, with little or no assistance from the teacher.

Researchers designed the LKPD to create an attractive appearance for students. This is done by adding illustrative elements of character images that are expected to increase visual appeal. In addition, each question is arranged in the form of instructional sentences that are inviting and interactive so that students are motivated to be actively involved in the learning process. Furthermore, each item has been designed in such a way by following the reference of self-directed learning theory by Knowles (1975) and the self-assessment scale readiness questionnaire for self-directed learning developed by Feby *et al.* (2019); the goal is to equip students with better self-learning skills.

C. Develop Phase

After completing the design stage, the next stage is the product development of visual novel educational games with three main applications: Ren'Py, Figma, and VRoid Studio. Ren'Py is a game development application using Python programming for the visual novel genre.

Figure 1 Game programming using Ren'Py application



The Figma app was used to design the interface which offers various features for creating assets such as backgrounds, navigation buttons, and menu displays. Character illustrations were created using the VRoid Studio app, which provides various customisable 3D templates. Once the design was complete, all assets were exported into image format and imported into the Ren'Py app, where the placement and addition of features were done through programming until the entire scene was connected according to the game's flow.

In line with the concept of visual novel genre games proposed by Camingue *et al.* (2020), The product development process in this study also adopted key features of visual novel games as effective teaching strategies. These features include interactive choices, such as dialogue selection and narrative sequences designed to evaluate player understanding through quizzes and story exploration. After development, the product underwent a validation process to ensure its feasibility in learning Natural and Social Sciences (IPAS), with media and material validity tests as assessment steps.

Table 1 Media expert validity test results

Aspect	Media Expert 1	Media Expert 2	Total Score	Average	Description
User Experience	21	23	44	91,66%	Very Valid
User Interface	39	42	81	92,04%	Very Valid
Language Selection	11	12	23	95,83%	Very Valid
Audio Selection	12	12	24	100%	Very Valid

The results of the media validity test show that the game has a very high level of validity, with an average score of 91.66% for the user experience aspect, 92.04% for the user interface, and 100% for audio selection. Based on these results, the visual novel media is considered very valid and feasible to use in learning.

Table 2 Material expert validity test results

Aspect	Media Expert 1	Media Expert 2	Total Score	Average	Description
Learning Design	12	10	22	91,66%	Very Valid
Use of Language	20	20	40	100%	Very Valid
Selection of Language	19	20	39	96,87%	Very Valid

The material validation results also showed a very high level of validity. The learning design aspect obtained an average score of 91.66%, while the aspects of language use and language selection received perfect scores of 100% and 96.87%, respectively. This study's results align with the findings of Galindra *et al.* (2023), who rated the game as accurate, relevant and engaging for users. Thus, this educational game is considered very feasible as an alternative learning media.

D. Implementation phase

The next stage is the implementation stage, where the visual novel-based educational game media is tested in the context of learning Natural and Social Sciences (IPAS). This trial involved the participation of 30 students of class 5A in one of the public elementary schools in Semarang, with help from the co-researchers. The implementation took place on 30 May 2024. The learning process began with introducing the teacher's research objectives and the concept of visual novel games to the students. Next, students were asked to fill out a pre-test to measure their initial ability to learn independently. After that, students downloaded and played the visual novel educational game while working on the Learner Worksheet (LKPD), which contained questions related to the material in the game.

In the media implementation process, educational game media based on visual novels equipped with Learner Worksheets (LKPD) is based on research findings. Budiastira *et al.* (2020) show great potential in integrating independent learning using learning media or other teaching materials in elementary schools. The developed visual novel educational game serves as a media that presents learning materials through attractive illustrations and stimulates students' interest in learning independently. In the media, independent tasks are provided that are relevant to the learning context, thus increasing students' independent learning ability to apply the knowledge gained by working on questions in the LKPD that has been distributed.

The learning process mediated through the visual novel game is under the theory of the stages of self-directed learning ability put forward by Grow (1991). According to the theory, primary school students are categorised as dependent learners in stage 1. Although school students are encouraged to learn independently, the teacher's role as an active facilitator is still crucial. When students learn independently by playing the educational visual novel game, the teacher not only functions as a supervisor but also actively goes around the classroom to monitor students' progress and aid students who are facing difficulties. After students have completed the visual novel game and worked on all the LKPD questions, the next stage is evaluation.

E. Evaluation phase

In the evaluation stage, the educational game that has been developed is then tested for effectiveness to evaluate how effective the visual novel educational game is in improving students' independent learning ability. As part of the evaluation process in measuring the level of media effectiveness, decision-making in this study uses the reference criteria listed in the N-Gain percentage table by Hake (1999). The criteria are based on calculating the percentage of the N-Gain score, which compares the average pre-test and post-test scores.

Table 3 Material expert validity test results

Percentage (%)	Interpretation
> 76	Effective
56 - 75	Quite Effective
40 - 55	Less Effective
< 40	Ineffective

To test the effectiveness of this media, a study was conducted with a one-group pre-test post-test design for 30 students of class 5A in learning Natural and Social Sciences (IPAS). This study used descriptive quantitative data analysis techniques to describe the results of the Gain normality test, which measures the increase in students' self-directed learning ability before and after using the media. The following presents the results of the comparison between pre-test and post-test scores.

Table 4 Comparison of Average Pre-test and Post-test Scores

Average Pre-test Score	Average Post-Test Score
53	87

After obtaining the average pre-test and post-test scores, the next step is to measure using the N-Gain formula. Based on the results of the analysis using the IBM SPSS application, the average N-Gain value obtained is 0.73 or 73%, with the conclusion that the educational game media based on visual novels is quite effective in improving the self-directed learning ability of class 5A students.

Table 5 N-Gain test results

	N	Minimum	Maximum	Mean	Std. Deviatoin
n-gain_score	30	.48	1.00	.7340	.15630
n-gain_percent	30	48	100	73.40	15.630
Valid N (listwise)	30				

The effectiveness of the media that only reaches the 'moderately effective' category and is not fully optimal for grade 5 elementary school students can be caused by several factors, such as the lack of maximum self-directed learning ability in students and the relatively short duration of using learning media during the study. This aligns with the theory Grow (1991) regarding the

stages of independent learning, which states that primary school students are generally in the early stages with a low level of independence. At this stage, students are considered dependent and unable to implement independent learning fully. They need guidance from teachers to provide feedback during the learning process and need time to adapt to become independent learners with support from teachers and parents. Trisiana *et al.* (2023) added that it is very reasonable. They stated that self-directed learning skills are relevant for adult learners and can be effectively applied to grade 5 primary school students. Implementing self-directed learning is important in increasing students' motivation and self-confidence. Overall, this study shows that using educational games based on visual novels contributes positively to developing students' self-directed learning skills, especially in the learning of Natural and Social Sciences (NSP).

The findings from this study suggest that while visual novel-based educational games have shown promise in enhancing self-directed learning in grade 5 students, their effectiveness could be further optimized with a longer duration of use and stronger development of students' self-directed learning skills. This limitation, as identified in the research, offers important insights for potential applications in other contexts, particularly in educational settings where students are in the early stages of developing independent learning abilities. The theory of Grow (1991) emphasizes that primary school students often require more time and teacher guidance to engage in self-directed learning fully. Thus, implementing such educational games in other environments, including middle school or adult education, could be beneficial by focusing on scaffolding strategies that support learners to transition into more independent learning stages. Additionally, adapting these games to meet the specific needs of different age groups and subjects could enhance their effectiveness, making them a versatile tool for various educational settings.

CONCLUSION

The research and development of learning media based on visual novel educational games led to several conclusions. First, the needs analysis revealed that students' learning outcomes in class 5A at a public elementary school in Semarang were unsatisfactory, as shown by their performance on daily tests and STS. This was due to students' low understanding of IPAS material, their habit of using smartphones for entertainment, and the lack of variety in learning media. The design of the visual novel educational game was aligned with IPAS competencies and included a competency map, material map, flowchart, GBIM, script, and LKPD. Second, the game development utilised Ren'Py, Figma, and VRoid Studio, with evaluations from media and material experts confirming the game's validity and feasibility. Third, implementing the game with 30 students in class 5A showed increased self-directed learning, with an N-Gain of 0.73, indicating its effectiveness. The researchers recommend that schools optimally utilise learning technology to support the Merdeka curriculum and suggest that teachers use this educational game to enhance the interactivity of IPAS learning.

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