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Analysis and Exploration of Hypermedia-Based Learning Materials Proyek IPAS in Grade 10 Vocational High School

Auliya Naimah[1*], Robinson Situmorang[2], Dwi Kusumawardani[3]

Universitas Negeri Jakarta, Jakarta, Indonesia

Author email: auliyanaimah_9901821001@mhs.unj.ac.id[1], rsitumorang@unj.ac.id[2],dwikusumawardani@unj.ac.id[3]

Abstract. One of the innovations arising from technological developments is using hypermedia in learning. Therefore, this study aims to identify learning needs in the development of hypermedia-based Proyek IPAS learning materials in Class X vocational schools. The research method used is Research and Development (R&D), the development model used in this study combines the Dick and Carey and Lee & Owens models, which focus on the development of hypermedia-based Proyek IPAS learning materials, both of which were chosen because they complement each other in the development of technology-based learning materials, especially in multimedia learning such as hypermedia. Data collection techniques used observation, questionnaire interviews, and learning outcomes tests. The results showed that students aged 15-16 can use technological devices such as laptops, tablets, and smartphones, but are more often used for entertainment than learning. Observations revealed the limitations of available learning materials, so interactive and appropriate hypermedia-based Proyek IPAS learning materials are needed. This research provides a basis for developing innovative and relevant hypermedia-based Proyek IPAS learning materials to support project-based learning in vocational high schools.

Keywords: Learning Materials, Projek IPAS, Hypermedia, Vocational School

1 Introduction

In the era of Industrial Revolution 4.0, education is characterized by utilizing digital technology (cyber system) in the learning process. The Internet and computers will facilitate the teaching and learning process. Teachers are expected to be able to manage information, effectively use learning media, choose the right methods, and use facilities and infrastructure that suit learning needs to create a creative, innovative and competitive generation. Technology certainly brings changes in mindsets, ways of working, and lifestyles [1], [2], [3].

The technology field is developing rapidly, resulting in changes in the world of education. The presence of technology provides benefits in the role of teachers in delivering learning, and with this technology, it is easier to get learning resources [4], [5]. Learning resources are defined as information presented and stored in various forms of media, which can assist students in learning as a manifestation of the

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curriculum. The form is unlimited, whether in the form of print, video, software, or a combination of several forms that can be used by students and teachers [6]. Thus, integrating technology into learning contributes to improving the quality of education and forming competent human resources ready to face global challenges [7].

One innovation arising from technological development is the use of hypermedia in learning. Learning materials are a means for learners to acquire knowledge and a tool for teachers to provide skills and foster learners' abilities. [8].

Hypermedia also supports multimedia learning theory, which emphasizes the importance of combining different media formats (text, images, video) to improve understanding and retention of information. Research by Mayer shows that learning involving multimedia and hypermedia is more effective in comprehension than text-based learning alone [9]. Hypermedia combines hypertext and multimedia (audio, image and animation) technologies to produce a media-rich web-based learning environment. Hypermedia allows students to access different content representations with nonlinear navigation [10]. Hypermedia integrating text, images, sound, and video can create a more interactive and engaging learning experience, thus increasing student motivation and understanding of the material [11], [12]. Hypermedia learning materials allow learners to learn independently and explore the material according to their interests and needs.

Vocational High School (SMK) is a formal education level that students increasingly demand because the learning process provides various practices and exercises in each expertise programme. SMK graduates are directed as graduates who are ready to work according to competencies in their fields of interest, capable of entrepreneurship and continuing education, competitive, and have strong character as a professional workforce needed in the world of work. Additionally, science process skills involve a series of logical steps that must be followed to obtain data, analyze it, and draw conclusions based on existing evidence [13].

Science learning in early childhood education, primary education, and secondary education in the independent curriculum is called the subject of the Natural and Social Sciences Project (Proyek IPAS) [14]. Natural and Social Sciences Project (Proyek IPAS) is a science that studies living and non-living things in the universe and their interactions. It also studies human life as an individual who is a social being who interacts with his environment [15]. Improving the quality of teaching by using multimedia can improve student engagement, where active student participation is a key element in the development of science process skills [16] Therefore, the development of hypermedia-based learning materials is an urgent need to fill this gap.

The observation results show that the IPAS learning resources used come from various references the teacher chose, but no complete and integrated teaching materials are needed. This causes obstacles in the learning process in the classroom. Interviews with learners revealed that not all students have textbooks, so they seek learning resources from the internet, friends, online tutoring, and teachers. However, due to the complex language, many have difficulty understanding the material from online sources. The questionnaire results show that 57.3% of learners need further explanation and find it difficult to identify the parts they do not understand. They want learning materials that are more concise and easy to understand. By utilising tools such as mobile phones and laptops. This suggests the need to develop additional learning resources that are more interactive and easy to understand [17].

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Research shows that innovative learning media, such as props and digital technology, can increase student engagement and understanding of the material [18]. Many studies show that digital skills play an important role in improving students' self-learning ability, which in turn contributes to the development of science process skills. Darmaji [19] suggested that there is a significant relationship between digital literacy and science process skills among junior high school students. This research shows that students who have better digital literacy skills tend to be better able to carry out self-learning activities and organize science knowledge more effectively. Digital skills enable students to access information more quickly, solve problems independently and make informed decisions.

In addition, Afifulloh & Cahyanto [20] research emphasises the importance of electronic teaching materials, especially in today's digital era, to improve learning effectiveness. By utilising technology, hypermedia-based Proyek IPAS learning materials can offer students a more engaging and immersive learning experience. Therefore, one of the ways that educators can do is to make the learning process active by utilising technological developments. The urgency of developing digital learning media, especially hypermedia-based, can be strongly justified in the context of the Industrial Revolution 4.0 and post-pandemic learning. So that in the teaching and learning process, students are not easily bored, and teachers also do not focus on the lecture method, namely learning materials that can display text, images, videos and animations [11]. The results of relevant research show that hypermedia learning materials positively impact student learning, especially in improving visualisation, concept understanding, steps in solving problems and improving students' creative thinking skills [21], [22], [23], [24].

This opinion is based on the results of a questionnaire 96.4% of students stated that students need hypermedia-based Proyek IPAS learning materials. This learning material can substitute for printed books with monotonous content that causes boredom in students. Developing hypermedia-based Proyek IPAS learning materials is necessary to improve learning effectiveness. Therefore, developing hypermedia-based Proyek IPAS learning materials is expected to answer this challenge by providing more varied and contextual learning resources. By using interactive media, students can more easily understand complex science and social concepts and relate them to their daily lives. [11], [12].

2 Research Method

The research was conducted at SMK Negeri 5 Kota Bekasi using the Research and Development (R&D) approach to develop hypermedia-based teaching materials for the Natural Science and Social Studies (Proyek IPAS) subject in grade 10. This study combined the Dick and Carey development model [25] with the Lee & Owens model [26], focusing on the development of hypermedia learning materials. These models were selected for their complementary strengths in developing technology-based learning materials, particularly multimedia-based learning, which in this research is hypermedia.

The Dick and Carey model focuses on instructional design stages, including needs analysis, material design, development, implementation, and evaluation.

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Meanwhile, the Lee and Owens model delves deeper into multimedia learning material development, emphasizing the use of technology in learning, making it highly relevant to the objectives of this study. The Lee and Owens development model consists of four stages: the first stage, need assessment and front-end analysis, identifies learning needs and potential material development; the second stage, multimedia instructional design, focuses on designing multimedia-based learning materials; the third stage, multimedia development and implementation, involves the creation and implementation of learning materials in educational settings; and the fourth stage, multimedia evaluation, assesses the effectiveness of the developed materials.

This study was limited to the initial analysis phase to identify learning needs for developing hypermedia-based teaching materials for grade 10 Proyek IPAS subjects. The initial analysis phase included two main steps: need assessment and front-end analysis, which helped explore current learning conditions, including the media used, available infrastructure, and the challenges faced by teachers and students in the learning process.

Data collection was conducted through two primary methods: interviews and direct observations. Interviews were conducted with grade 10 teachers and students to gather information about learning needs, technology usage, and challenges in the IPAS learning process. Direct observations were carried out in classrooms to assess real-time learning conditions and identify available facilities such as computers, laptops, and mobile devices that could be utilized for technology-based learning. Observations also examined technical and non-technical obstacles encountered during the learning process.

The data obtained from interviews and observations were then analyzed using descriptive analysis techniques. Descriptive analysis involved organizing and categorizing data into themes based on respondents' answers. This approach provided a clear overview of students' and teachers' needs regarding hypermedia-based teaching materials and the learning challenges that could be addressed by developing more effective and tailored teaching materials.

3 Result and Discussion

Based on the needs assessment results and front-end analysis, it aims to identify learning needs in the development of hypermedia-based Proyek IPAS learning materials in grade X vocational high schools.

3.1 Need Assesment

Based on the results of interviews and observations, among others, learning media that utilize technology are still quite rarely used. Teachers more often use conventional books in teaching in class. Learning tends to be one-way and teacher-centered. The assignments given by the teacher in the learning materials used are still classified into questions that are similar to the sample questions contained in the teaching materials. However, this approach is less attractive to students because it is passive and less interactive.

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Based on the results of the learner needs questionnaire, it was found that students want learning materials that are more interactive, dynamic and easily accessible, especially through technological devices such as smartphones, tablets or laptops. Therefore, one of the ways that educators can do is to make the learning process active by utilising technological developments. So, in the teaching and learning process, students are not easily bored, and teachers also do not focus on the lecture method, namely learning materials that can display text, images, videos and animations [11]. In addition, with digital technology, students now have greater access to various learning resources, including e-learning, instructional videos, and virtual laboratories, which provide more flexible and diverse learning paths [27].

3.2 Learner analysis

This analysis aims to understand learners' characteristics, needs and challenges in supporting the development of relevant and effective hypermedia-based Proyek IPAS learning materials. Based on the results of the identification of characteristics in SMK Negeri 5 Kota Bekasi, grade X students have a homogeneous or the same socio-cultural background because most students are relatively the same age, 15 - 16 years old, which is a transition period from early adolescence to late adolescence, very interested if the teacher teaches using the media, likes challenges, likes social media and has a tendency to follow peers. The following is the distribution of students.

Table 1. Number of Student

No.	Class	Number of Student		Total
		Male	Female	
1.	X TEI 1	31	3	34
2.	X TEI 2	29	6	35
3.	X TEI 3	30	6	36
4.	X TEI 4	29	6	35
5.	X RPL 3	24	14	38
Total Number of Student		143	35	178

TEI = Teknik Elektronika Industri; RPL = Rekayasa Perangkat Lunak

Learners at the Vocational High School (SMK) level are between 15 and 18 years old and have diverse learning needs [28]. Therefore, hypermedia learning materials are customised and flexible to suit learners' needs.

3.3 Technology Analysis

This analysis aims to determine the availability of technology in supporting the development of hypermedia-based learning materials for Proyek IPAS subjects in grade X SMK. Based on the technology analysis, the school has LCD projectors in some classrooms that can be used to support learning and stable internet access in some areas, allowing learners and teachers to access learning resources. Most learners also have personal devices such as tablets or mobile phones. Learners can access hypermedia-based Proyek IPAS learning materials through mobile phones.

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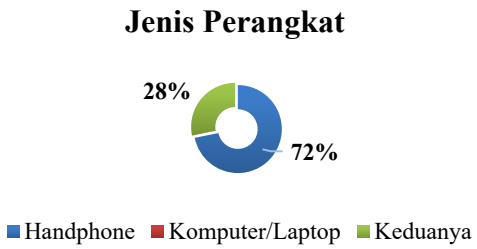

Fig. 1. Device Type

Based on the technology analysis, possible solutions include developing hypermedia-based learning materials that can be accessed through devices such as laptops, tablets and mobile phones. Research shows that innovative learning media, such as teaching aids and digital technology, can increase student engagement and understanding of the material [18]. According to Alenezi et al., [29] integrating digital technology in education gives students wider access to information and enhances the learning experience. Although supporting technologies are available, some challenges need to be considered, such as limited internet access in some areas and the varied digital capabilities of learners. Therefore, the development of hypermedia-based Proyek IPAS learning materials must consider user-friendly, lightweight and offline accessible design to support more inclusive learning.

3.4 Task Analysis

This analysis aims to identify the grouping of learning materials, competencies to be achieved, and specific tasks that need attention. The learning process of the Natural and Social Sciences Project on the aspect of living things and their environment, substances, and their changes consists of grouping material on the characteristics of living things, the environment, interactions between ecosystem components and environmental pollution, form and composition, separation of mixtures, properties of matter, measurement, changes in matter and hazardous and toxic materials (B3) in class X of all expertise programmes. This task analysis is based on the Learning Outcomes that refer to the independent curriculum. [14]

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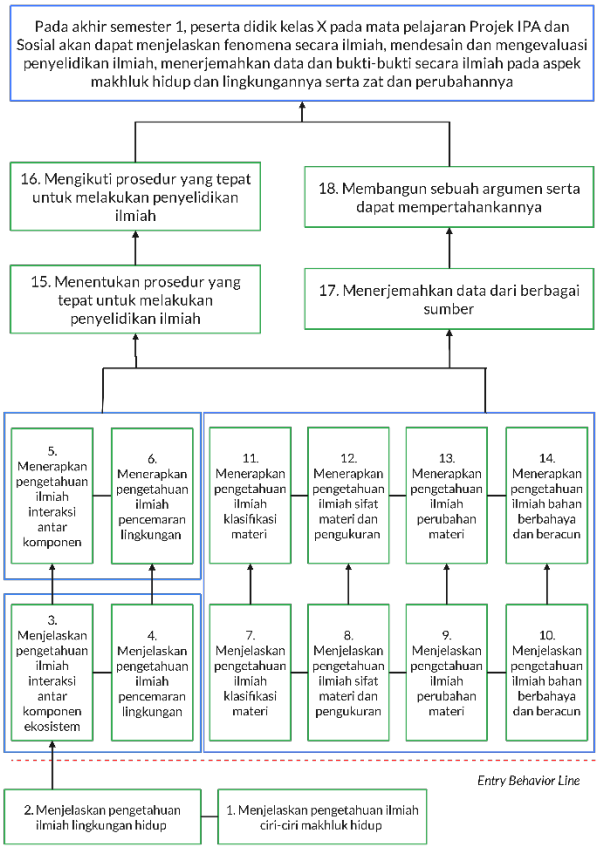

Fig. 2. Task Analysis

3.5 Critical Incident Analysis

In this phase, the required knowledge and skills are determined. This phase is conducted to find tasks that learners must complete to achieve learning objectives based on the curriculum. Critical incident analysis results in learners explaining phenomena that occur in the surrounding environment, which are seen from various aspects, such as living things and their environment, as well as substances and their changes. Learners can determine and follow the right procedures for conducting scientific investigations, explain the right way of investigating a scientific question, and are expected to identify flaws or errors in the design of scientific experiments. Learners can interpret data and evidence from various sources to build an argument and defend it with a scientific explanation. Based on the results of this analysis, the development of hypermedia-based learning materials will be designed to facilitate these skills more interactively.

3.6 State Analysis

A State's analysis is conducted to understand the current learning conditions, including internal and external factors that affect the learning process in the Natural and

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Social Science Project (Proyek IPAS) in grade X vocational schools. The state analysis shows that the learning environment is comfortable, the air circulation is good, and the class size is appropriate for the number of students. The classroom is supportive and creates a comfortable situation during the teaching and learning process. In addition, supporting facilities such as tables, chairs and whiteboards are available in sufficient quantities and in a suitable condition. When school facilities are well maintained, students will feel more comfortable and safe, which in turn can improve their concentration and learning outcomes [30].

3.7 Objective Analysis

Objective analysis is carried out to ensure that the designed learning materials can be used to improve the quality of teaching and achieve the desired learning outcomes. This analysis aims to determine the competencies, skills, and knowledge students need to master. The general instructional objective for the Proyek IPAS subject in the first semester is to explain phenomena scientifically, design and evaluate scientific investigations, and interpret data and evidence from a scientific perspective regarding living organisms and their environment, as well as substances and their changes. Meanwhile, the specific instructional objectives for the first semester of the Proyek IPAS are:

a. After studying the material and completing an interactive quiz with at least 80% correct answers, students can explain their scientific knowledge of the characteristics of living organisms.
b. Students can explain scientific knowledge about the environment.
c. After completing a field observation and making a report, students can explain the scientific knowledge of ecosystem component interactions with 90% accuracy on the questions.
d. After an interactive quiz, students can explain scientific knowledge about environmental pollution with at least 80% correct answers.
e. By identifying the characteristics of five different organisms, students can apply scientific knowledge about the characteristics of living organisms to practical activities.
f. Students can apply scientific knowledge about the environment by observing the school environment and producing a simple report.
g. Students can apply scientific knowledge about ecosystem component interactions after observing the school environment and identifying at least three occurring interactions.
h. Students can apply scientific knowledge about environmental pollution after conducting a mini-project over two weeks.
i. Students can explain scientific knowledge about material classification after studying the material and completing a quiz with at least 90% correct answers.
j. After conducting laboratory experiments, students can explain scientific knowledge about the properties of matter and measurement, demonstrating conceptual understanding.
k. After watching an educational video and providing examples of physical and chemical changes, students can explain scientific knowledge about material changes.

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l. After reading a text on B3, students can explain scientific knowledge about hazardous and toxic materials by mentioning at least five examples of hazardous materials in daily life.
m. Students can apply scientific knowledge about material classification.
n. After conducting experiments, students can apply scientific knowledge about the properties of matter and measurement, achieving at least 80% accuracy in their results.
o. Students can apply scientific knowledge about material changes in a class project by correctly demonstrating chemical changes.
p. After completing a case study with at least 80% accuracy on the assignment, students can apply scientific knowledge about hazardous and toxic materials.
q. Students can determine the correct procedure for conducting scientific investigations after discussing in groups, with at least 80% accuracy on the provided case.
r. After receiving step-by-step guidance and practising in the laboratory, students can follow the correct procedure for conducting scientific investigations with at least 85% accuracy.
s. Students can interpret data from various sources after collecting data from literature, surveys, and experiments, achieving at least 80% data accuracy in their analysis.
t. Students can build an argument and defend it after completing a mini-project

Research by Awaludin et al. [NO_PRINTED_FORM] [31] highlights the importance of good instructional design in achieving optimal learning outcomes.

3.8 Media Analysis

The media analysis to be used in the IPAS project subject of grade X SMK is hypermedia-based learning materials. In the process of developing hypermedia-based learning materials for the Grade X SMK Natural and Social Sciences (IPAS) Project subject, the types of media components used-such as text, video, animation, and interactive elements-have been systematically designed and adapted to the learning objectives stated in the Learning Outcomes (CP) of the Merdeka Curriculum. The text component is used to convey basic concepts in a narrative and descriptive manner, while learning videos are intended to provide concrete visualization of scientific processes and phenomena. Animation is used to illustrate processes that are complex or cannot be observed directly, such as the characteristics of the form of matter. Interactive elements - such as quizzes, simulations on the use of measuring instruments such as a vernier caliper and screw micrometer - are used to increase students' active participation, reinforce understanding, and support independent and exploration-based learning.

All these components have been aligned with the learning objectives of IPAS, which is to shape students' science literacy through a collaborative and contextual approach. The media selection also considers the characteristics of vocational students, infrastructure limitations, and technology-based learning design principles.

To improve the quality of vocational education in the era of the Fourth Industrial Revolution, educators must understand the methods, strategies, and learning materials used for teaching to meet educational needs [17]. Hypermedia not only serves as a tool

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for delivering information but also supports a more structured and guided learning process tailored to the individual learning needs of each student to achieve effective learning [32]. Therefore, teachers are expected to continue developing and implementing teaching content relevant to the demands of current technological advancements [13].

3.9 Extant Data Analysis

At this stage, it was found that teachers have created learning materials for the Proyek IPAS subject in the form of PowerPoint presentations. However, the materials still require some improvements. It was also found that the existing materials have not yet been effective in improving student learning outcomes. Teachers are still encouraged to include learning resources in their subjects even though most learning is now done in a differentiated way. Today, educators use various media, such as pictures, films, videos, and more. To address these gaps, the proposed hypermedia product is designed as an innovative solution that presents materials in multi-formats (text, images, video, animation and interactivity). This product not only conveys information, but also provides a more immersive, adaptive, and contextual learning experience. By utilizing the potential of digital technology, hypermedia teaching materials can bridge the shortcomings of previous materials.

Teachers should use learning resources close to children's environment because students still need real objects [33].

3.10 Cost Analysis

The cost analysis aims to identify and calculate the costs of developing hypermedia-based Proyek IPAS learning materials. The calculated components include the cost of content development, software procurement, expert labour, testing and validation. At this stage, cost analysis was not conducted because it was aimed at academic activities, not business. Nevertheless, the cost aspect remains a consideration in the selection of technology, media design, and testing methods so that the development of learning materials can be implemented effectively without burdening educational institutions.

4 Conclusion

Based on the study results, it can be concluded that the characteristics of students aged 15 - 16 years. The development of hypermedia-based Proyek IPAS learning materials is recommended because printed books have limitations in delivering visual aspects and the amount available. Therefore, it is necessary to have hypermedia-based learning materials to help overcome the shortcomings of available learning materials and facilitate the learning process. Hypermedia-based learning materials will be created using the Dick and Carey development model and combined with Lee and Owens.

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