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Analysis of the Use of PjBL in Mobile Application Development with Artificial Intelligence Library in XIF1 SMAN 3 Surakarta

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Abstract:

Indonesia continues to improve the quality of education in order to compete regionally and globally. This research was conducted at SMA Negeri 3 Surakarta on students of class XI F1, consisting of 36 students. The focus of the research is to evaluate the effectiveness of *Project Based Learning* (PjBL) method in learning Mobile Application Development with Artificial Intelligence Library. Data were collected through classroom observation, interviews with Informatics teachers, and questionnaires to students. The results showed that the PjBL method was effective in improving students' understanding of the material taught. In addition, this method also helps students develop important skills, such as collaboration, problem solving, and project management. Students showed significant improvement in working in groups, sharing tasks, and solving problems. Thus, PjBL not only improves academic understanding, but also skills that are useful for students' future.

Keywords: *Analysis, Comprehension, Project Based Learning*

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Introduction

Indonesia is one of the countries in Southeast Asia that is categorized as a developing country. Various sectors in Indonesia continue to make improvements in order to compete with other countries, both at the regional and global levels. The education sector is one of the main focuses in this effort, because the education sector is considered the main key to producing quality human resources. The development of a good education sector is expected to produce individuals who have knowledge and skills that are in accordance with current global needs. Education is an organized, planned and sustainable effort (continuously throughout life) with the aim and direction of fostering students to become better individuals in carrying out their lives where a person's life includes maturity and civilization (Herdiansyah & Poni, 2020).

The Ministry of Education, Culture, Research and Technology is an institution established and mandated by the Indonesian government to manage the country's education sector. The Ministry is responsible for formulating, implementing and evaluating education policies that aim to improve the quality of education at all levels, from primary to tertiary education. In an effort to achieve this goal, the Ministry continues to make various innovations that are tailored to the conditions and needs of Indonesian society. These innovations include curriculum development, learning methods, learning media and teacher training. Learning methods or strategies are so important to use in the learning process to minimize the monotony of learning that can cause students to quickly feel bored to make students' interest in learning according to (Albina et al., 2022).

One of the approaches adopted is Project Based Learning (PjBL), which is considered an effective learning method for developing practical skills and critical thinking. PjBL emphasizes on a student-centered learning process, with

projects as the core of the learning process, where students are expected to complete projects that require complex problem solving, research, collaboration, and presentation of final results. Through PjBL, students not only learn theory but also apply it in real situations, which encourages active engagement and higher learning motivation. Projects usually challenge students to work in teams, find creative solutions, and communicate their work clearly. The disadvantages of Project Based Learning include requiring a lot of time to solve the problem, requiring a lot of money, many educators are comfortable with the traditional classroom, where the educator plays the main role in the classroom, the amount of equipment that must be provided, learners who have weaknesses in experiments and information gathering will experience difficulties, there is a possibility that there are learners who are less active in group work, when the topics given to each group are different, and it is feared that learners cannot understand the topic as a whole (Simangunsong et al., 2022).

Teachers have an important role in choosing learning methods that are in accordance with the characteristics and learning styles of diverse students. Choosing the right learning method will help students understand the material better. If the learning method used by the teacher is appropriate, the achievement of learning objectives will be easier to achieve, so that the value of student learning completeness will increase, student interest and motivation to learn will also increase and a pleasant learning atmosphere will be created (Wibowo & Lamtioma, 2019).

Related Work

This research focuses on analyzing the application of Project Based Learning (PjBL) in mobile application development material using artificial intelligence library in Class XIF1 SMA Negeri 3 Surakarta. In the research process, the author explored various sources of relevant literature, and managed to identify a number of important writings that provide deep insights into the application of this method in the context of education.

Previous research conducted (Anggraini & Siti, 2021) with the title Analysis of the Use of the Project Based Learning Model in Increasing Student Activeness. The problem discussed in this study is the impact of using the Project Based Learning learning model on class X OTKP at SMK Negeri 2 Blitar. The results showed that Project Based Learning was able to influence the increase in student activeness in the learning process and student activeness could also affect learning outcomes in the end.

Previous research conducted (Sakinah et al., 2023) with the title Increasing Student Learning Activeness by Using the Project Based Learning Model. The problem discussed in this study is that the Project Based Learning model is implemented in order to provide a different learning experience and of course be part of the implementation of the 2013 Curriculum, namely making students active through learning accompanied by an appropriate learning model. The results showed that the application of the Project Based Learning model can increase activeness and improve learning outcomes obtained by students. The application of this model also provides a more detailed, meaningful and detailed learning experience with a longer duration than other learning models.

Previous research conducted (Fatimah & Bramastia, 2022) with the title Literature Review Project based learning Based on ICT. The problem discussed in this study is to find literature in previous journals regarding the implementation of the Project Based Learning model in ICT learning. The results showed that there were 52 journals that showed implementation in teaching materials and learning media. ICT-based Project Based Learning teaching materials in the form of e-lkpd, e-module, e-book and e-protfolio. ICT-based Project Based Learning learning media in the form of virtual tour, Kit, robotics, website, virtual laboratory, e-learning, application, photo, flip pdf, PPT, multimedia, AR and moodle.

Previous research conducted (Iasya et al., 2024) with the title Application of Project Based Learning Model to Improve Student Learning Outcomes of Informatics in Class X 4 SMA Negeri 4 Maros. The problem discussed in this study is the impact of applying the Project Based Learning model for learning Informatics in class X4 students of SMA Negeri 4 Maros. The results showed that there was an increase in learning outcomes in Informatics lessons by 26.51% points in the comparison of the average pretest score (57.55%) which did not use the Project Based Learning method with the average posttest (84.06%) which used the Project Based Learning method.

Research Method

The method used in this research is a qualitative method. Qualitative method is a method used to examine a natural object in order to get a description / description and in-depth understanding where the researcher has a role as an instrument (Setiawan et al., 2022). Researchers are directly involved in collecting data through observations, interviews, and questionnaires to understand what events occur in the field.

The subjects of this study were students of class XIF1 at SMA Negeri 3 Surakarta totaling 36 students, consisting of 14 male students and 22 female students. Data were collected through direct observation in the classroom, in-depth interviews with one of the Informatics teachers at SMA Negeri 3 Surakarta, and questionnaires distributed to students. The teacher was chosen as the main resource person because she has deep insight into the behavior and academic achievement of students in class XIF1. The questionnaire must go through the validity and reliability stages to ensure that the tool used can indeed measure the required variables accurately and consistently (Rahman et al., 2024). The use of questionnaires to students to collect data on their views on teaching methods, materials taught, and the learning environment in the classroom.

Data analysis was carried out using a qualitative descriptive method, which included a detailed description of all research results. Data analysis techniques were carried out with 3 stages, namely data reduction, data presentation, conclusion drawing/verification. Data validity uses method triangulation, namely comparing the results of the representation ability test with the results of the interview (Irwan et al., 2023). The data reduction stage involves selecting and simplifying relevant information. Data presentation aims to display data systematically so as to facilitate understanding. The final stage, conclusion drawing, involves interpreting the data to answer the research questions and achieve the research objectives. With this approach, researchers can understand and describe phenomena in depth.

Result and Discussion

The implementation of the independent curriculum requires students to play a more active role in the learning process, while the teacher acts as a facilitator. In order for students to more easily understand the material presented, it is necessary to choose the right learning method. Effective learning methods will encourage students' active participation, increase their involvement in every activity, and facilitate deeper absorption of knowledge. Teachers are expected to be able to choose and adapt methods that suit the needs and characteristics of students, as well as create a conducive learning environment. Thus, students can develop into critical, creative, and independent individuals in the learning process.

Project Based Learning (PjBL) is a learning method that uses projects or activities as the main media. This method requires students to explore, evaluate, collaborate, and play an active role in the learning process, by utilizing information to produce various forms of learning outputs (Zuhdiyyah et al., 2023). In an era of education that increasingly emphasizes the development of 21st century competencies, active and participatory learning methods are becoming increasingly important. Learners are no longer just recipients of information, but are also expected to be able to act as creators and innovators in the learning process. This Project Based Learning uses a real task method that encourages students to think actively, creatively, and engage in the design and manufacture of products related to learning materials (Faslia et al., 2023). In this context, students learn to design, implement, and test their projects, which directly teaches time management skills, responsibility, as well as relevant technical skills. In addition, with the guidance of the teacher as a facilitator, students get constructive feedback, which helps them to continuously improve and achieve optimal results. PjBL also integrates learning with the real world, so students are more motivated and feel that learning becomes more meaningful. This allows them to understand more complex concepts and apply them in various situations relevant to everyday life.

Figure 1. Implementation of Learning with Project Based Learning Method

Figure 1 shows the implementation of Project Based Learning (PBL) where learners are tasked with developing a mobile application. Students work collaboratively in a computer lab, using software to program the application they create. Students are encouraged to work in teams to develop mobile applications, engage in active problem solving and apply their programming knowledge in a practical context. Teachers facilitate learning by providing guidance, addressing technical challenges and helping students to understand and implement their ideas effectively (Nurbekova et al., 2020).

Result

Based on the results of processing the data that has been collected, there are the following results:

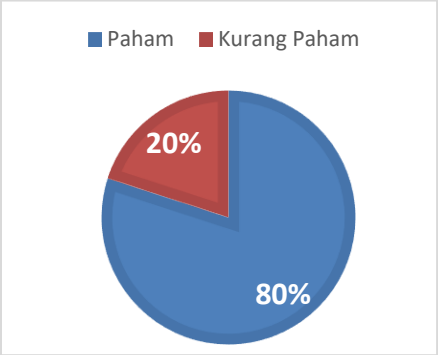

Figure 2. Percentage of Impact of Using PjBL in Supporting Student Understanding

Based on the data collected by the researchers and displayed in figure 2, the application of Project Based Learning (PjBL) on the material of Mobile Application Development with Artificial Intelligence Library in class XIF1 SMA Negeri 3 Surakarta gave positive results. As many as 80% of students felt that this method made it easier for them to understand the material and helped them learn more effectively. They also revealed that this approach makes learning more interesting and relevant to real life. PjBL allows students to be actively involved in the learning process, as well as develop critical and creative thinking skills. In addition, this method helps students connect the theories they learn in class with practical applications in everyday life.

However, there are 20% of students who still face difficulties in following learning with this method. Some of the challenges they face include difficulties in working independently and collaborating in groups. Some students may need more guidance and support in order to adapt to the PjBL method. In addition, their lack of time management skills and difficulty in organizing their tasks were also obstacles for them. Therefore, further efforts are needed to provide additional support and adjust learning methods so that all students can benefit optimally from PjBL. This support can be in the form of specialized skills training, improved communication between students and teachers, and constructive feedback.

Discussion

These results are in line with interviews conducted with one of the Informatics subject teachers, who explained that XIF1 class students at SMA Negeri 3 Surakarta tend to like and understand Mobile Application Development material using the Artificial Intelligence library more easily when the PjBL method is applied. The project-based learning (PjBL) model has a high categorical effectiveness on students' concept understanding (Novebrini et al., 2021). PjBL

encourages students to apply knowledge in relevant contexts, deepen understanding, and improve critical and collaborative thinking skills.

The results of the data visualization in the form of a pie chart show that the majority of respondents, namely 80%, have a good understanding of the material or information provided. Meanwhile, the other 20% of respondents are recorded in the "Less Understanding" category. Although quantitatively this figure seems quite encouraging, especially because the proportion of those who understand dominates, the existence of 20% of respondents who do not fully understand is an important issue that should not be ignored. The high percentage of understanding (80%) can be interpreted as an indicator of the success of the information delivery method used. This shows that most respondents can receive, absorb, and understand the material effectively. In the context of education or training, this achievement indicates that the method used is in accordance with the learning style of the majority of participants. However, this achievement is not yet fully optimal, because there are still groups who have difficulty understanding the information delivered. This gap leads to the importance of further evaluating the factors that influence respondents' understanding. First, the method of delivering the material has a major influence in shaping the level of understanding. The one-way lecture method, for example, tends to be less effective for participants with kinesthetic or visual learning styles. Second, the complexity of the material is also a major cause, especially if the material is delivered without adequate contextualization or illustration. In addition, differences in educational background, experience, and initial abilities of each individual also influence the success of their understanding.

On the other hand, respondents who fall into the “Lack of Understanding” category indicate that there is still an urgent need to improve the instructional approach. Failure to understand information can have significant impacts, both in academic, professional, and social contexts. In the workplace, for example, a lack of understanding can lead to errors in implementing procedures, decreased productivity, or even creating occupational safety risks. In the context of learning, this can lead to gaps in achievement between individuals and reduce enthusiasm for learning. Several studies support the importance of mapping learning styles and personal approaches in improving understanding. The learning differentiation model—which is the adjustment of methods and media based on participant profiles—has been shown to increase the effectiveness of information delivery. Meanwhile, the use of interactive media such as videos, simulations, and group discussions has been widely associated with increased absorption of material. The quality of participants' understanding can also be a parameter for assessing the effectiveness of a program or intervention. If some participants do not understand, then this is a reflection that the delivery of information is not fully inclusive or adaptive to the diversity of audience characteristics. Therefore, activity organizers need to design a more in-depth formative evaluation to identify the obstacles faced by participants during the learning or training process.

Furthermore, the differences in the level of understanding reflected in this data need to be seen not only as static results, but as a reflection of the dynamics of the learning process, communication, and interaction between the material deliverer and the information recipient. The uneven level of understanding indicates a more complex challenge than just the effectiveness of the material delivery. This also concerns the context of the learning environment, the mental readiness of the participants, and structural barriers such as access to learning resources and technological support. One important aspect to analyze is the gap in access to information. In today's digital era, many individuals still have difficulty accessing learning resources optimally, either due to limited devices, digital skills, or internet connections. If the material delivery process is carried out online, this will greatly affect the quality of participants' understanding, especially those in the "Less Understanding" group. Therefore, an inclusive approach is needed so that the material can be received in various formats—either digital, print, or face-to-face—in order to adapt to the diverse conditions of participants.

In addition to the main factors that have been discussed, it is also important to highlight other dimensions that indirectly affect the gap in understanding among respondents, especially in terms of active participant participation and learning environment support. First, active participant engagement is a fundamental element in meaningful learning. Participants who only act as passive recipients of information tend to have a low level of retention of the material presented. This is different if participants are involved in problem-based activities, group discussions, direct practice, or personal reflection. This kind of involvement creates a deeper meaning construction process and has an impact on increasing understanding. Therefore, learning strategies need to be designed in such a way that participants are not only physically present, but also cognitively and affectively activeSecond, the learning environment, both physical and social, plays an important role in shaping the mental readiness of participants to learn. A comfortable, quiet, and emotionally supportive learning space will encourage participants' focus and concentration. A supportive social environment, such as two-way communication, mutual respect, and appreciation for questions or criticism, can foster a sense of security to ask questions and explore information more deeply. This is crucial, especially for participants who may feel unsure about their understanding and are reluctant to express their ignorance. Third, one-way and uniform learning is very prone to leaving some participants behind. For this reason, it is necessary to apply a content differentiation approach, namely presenting material in various forms and levels of difficulty. For example, for

participants who quickly grasp the material, advanced content or practical application projects can be provided. Meanwhile, for participants who need more time, summaries, infographics, or explanatory videos can be provided. This approach is not only pedagogically fair, but also ensures that no participants are left behind because the method does not suit their learning needs. Fourth, the need for continuous monitoring and assessment is a major concern. Evaluation is not enough to be done only at the end of a session or program. Regular monitoring through mini-quizzes, interactive polls, or open discussions can be an early diagnosis tool for gaps in understanding. If there is a pattern of collective ignorance, this can be a signal for the facilitator to repeat or deliver the material in a different way. Formative assessment can also validate the extent to which participants understand the material progressively, not just as a final measurement. In addition, it should not be forgotten that the role of emotions and self-confidence also influences understanding. Participants who experience anxiety, fear of being wrong, or low self-esteem tend to be reluctant to ask questions or participate actively. In this condition, building a fun, open, and non-judgmental learning atmosphere is the key to unlocking each individual's learning potential. Furthermore, this discussion also emphasizes the importance of conducting a systematic learning needs assessment before designing materials or training. By knowing the starting point of the participants, the material compiler can adjust the content and strategies that are right on target. This mapping can be done through a preliminary survey, pre-test, or short interview that explores previous knowledge and experience.

In the study of educational psychology, the process of understanding is not only determined by a person's cognitive abilities, but also by motivational and affective factors. Information processing theory states that individuals must go through the stages of attention, encoding, storage, and retrieval to be able to understand a material effectively. If one of these stages is disrupted—for example, participants are not focused when the material is delivered—then the understanding process will not be optimal. In addition to cognitive aspects, intrinsic motivation also plays a big role. Participants who feel personal relevance to the material—whether due to professional needs, curiosity, or personal interests—tend to be more active in absorbing and processing information. Meanwhile, affective aspects, such as feelings of safety, appreciation, and not being pressured, have also been shown to influence participants' openness in participating in learning and asking questions when they do not understand. Therefore, learning design that pays attention to emotional support, such as providing affirmation, positive feedback, and a non-judgmental learning environment, is an important strategy to support comprehensive understanding. Cultural aspects influence how a person interprets, receives, and processes information. In the context of a multicultural society such as Indonesia or other developing countries, language is often a major challenge. The use of technical terms, foreign idioms, or complex sentence structures without contextual translation can be a barrier for certain groups in understanding the content of the material. Therefore, linguistic adjustments that are appropriate to the local context are needed. Furthermore, culture also shapes learning styles and social interactions. In many Eastern cultures, including Indonesia, participants tend to be reluctant to express opinions or ask questions because of the value of "sahaha suhan" or social hierarchy between teachers and participants. As a result, even though they do not understand, they choose to remain silent. This is very different from Western culture which emphasizes critical participation. In addition, collective values in certain cultures encourage community-based learning. In this context, peer learning can be more effective because participants feel more comfortable discussing with peers. Therefore, education and training strategies must consider cultural dimensions, both in the use of language, interaction approaches, and methods of reinforcing local values to improve understanding.

Visual communication is an important tool in the process of conveying information, especially to bridge the gap in understanding. Images, diagrams, infographics, and videos can clarify abstract concepts that are difficult to understand if only conveyed verbally or textually. According to the dual coding theory by Allan Paivio, information conveyed through two channels (verbal and visual) will be easier to understand and remember because it is processed through two different cognitive systems. However, the effectiveness of visual communication also depends on the quality of its design. Visuals that are too busy, inconsistent, or irrelevant can actually be confusing. Therefore, instructional design principles such as simplicity, readability, color contrast, and emphasis on main points must be considered. In addition, the arrangement of visuals needs to consider cultural aspects—certain symbols and colors may have different meanings in different groups of people. In the digital era, the use of interactive animations, web-based simulations, and multimedia presentations is becoming increasingly important in supporting adaptive learning processes. When designed well, visual communication not only improves understanding but also strengthens long-term information retention.

This discussion confirms that a high level of understanding (80%) is a positive indicator of the effectiveness of material delivery, but the existence of 20% of respondents who still do not understand should not be ignored. This inequality reflects the need for a more adaptive, inclusive, and contextual learning approach, taking into account cognitive, cultural, emotional, and technological factors. Improvement efforts should not only target delivery methods and media, but should also involve increasing the capacity of facilitators, preparing materials based on needs, and strengthening the feedback system. Thus, participant understanding can be improved evenly and sustainably, so that learning

objectives or information dissemination can be achieved optimally in various contexts. This discussion has examined various factors that influence understanding, ranging from differences in learning styles, digital access, socio-cultural backgrounds, to the emotional conditions of participants. Various intervention strategies have been identified, including the importance of a content differentiation approach, the use of visual media, optimization of educational technology, and strengthening the role of responsive and humanistic facilitators. In addition, the importance of a continuous monitoring and feedback system is a key element in ensuring program effectiveness. In a broader context, inequality in understanding also reflects structural inequality in access to information and learning opportunities. Therefore, efforts to improve understanding must be framed within the framework of transforming a learning system that is more equitable, inclusive, and adaptive to changing times. With a holistic and collaborative approach, both from the side of program managers, educators, and participants themselves, the challenges of inequality in understanding can be minimized. The hope is that all participants have an equal opportunity to understand, criticize, and apply information in real life effectively. This is an important foundation in building the quality of human resources that are competent, critical, and ready to face global challenges collectively.

Conclusion

Based on the results of this study, it can be concluded that the use of projcet based learinng (PjBL) learning method is proven effective in improving the understanding of XIF1 students at SMA Negeri 3 Surakarta on mobile application development material using artificial intelligence library. In addition to increasing understanding, this method also helps students develop collaboration, problem solving, and project management skills. During the learning process, students learn to work in teams, share tasks, and communicate effectively. They are also motivated to think critically and find creative solutions to the technical challenges they face. However, the implementation of the PjBL method also encountered some challenges, such as students' difficulty in understanding the more complex concepts of artificial intelligence and the limited time and resources available. Therefore, additional support, such as training and adequate resources, are needed to overcome these obstacles and ensure the success of the PjBL method in the future.

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