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Effectiveness of PjBL-Based E-LKPD Implementation in Teaching Plant Tissue Materials

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Abstrak: Penelitian pengembangan ini dilakukan berdasarkan kesulitan guru. Penelitian ini dilakukan dengan tujuan untuk menghasilkan e-LKPD yang valid, praktis, efektif dan menarik untuk peserta didik pada materi jaringan tumbuhan. Model pembelajaran yang diterapkan diharapkan dapat membantu guru dalam membuat media pembelajran yang menarik. Metode penelitian ini menggunakan metode Sistematic Literature Review (SLR) digunakan sebagai metodologi penelitian dalam tulisan ini. Ini berarti memilih setiap jurnal atau penelitian sebelumnya dan mengumpulkan hasilnya sebagai rujukan untuk model atau ide yang akan dikembangkan studi literature, dengan mengumpulkan informasi dan data dari sumber-sumber yang terpercaya seperti, jurnal ilmiah internasional, prodising seminar, laporan penelitian dan buku referensi. Data dalam penelitian ini adalah kajian literatur berupa penelitian-penelitian terdahulu yang berasal dari jurnal-jurnal pada tahun 2020 hingga 2024. Dari beberapa artikel ilmiah yang diteliti dan dibandingkan hasil penelitiannya, dapat disimpulkan bahwa beberapa penelitian yang menggunakan model simulasi dalam pembelajarannya telah berhasil diterapkan dan diaplikasikan kepada siswa dan guru, baik dari tingkat sekolah dasar maupun sekolah menengah kejuruan.
Kata kunci: e-LKPD; PjBL (Project Based Learning); Jaringan Tumbuhan.

Abstract:
This development research was conducted based on the difficulties faced by teachers. The aim of this research is to produce an e-LKPD that is valid, practical, effective, and appealing for students in the subject of plant tissues. The applied learning model is expected to assist teachers in creating engaging learning media. This research employs the Systematic Literature Review (SLR) method as its research methodology. This involves selecting each relevant journal or prior study and compiling their results as references for the model or idea to be developed. The study involves collecting information and data from reliable sources such as international scientific journals, seminar proceedings, research reports, and reference books. The data in this research consists of a literature review of previous studies sourced from journals published between 2020 and 2024. From several scientific articles that were examined and compared, it can be concluded that several studies using simulation models in their learning processes have been successfully implemented and applied to both students and teachers, at the elementary school and vocational high school levels.
Keyword: e-LKPD; PjBL (Project Based Learning); Plant Tissues.

1. Introduction

Education is a conscious effort made by society and the government through guidance, teaching, or training activities that take place in schools and outside of schools throughout life, aimed at preparing students to play their roles appropriately in various life environments and in the future. Education is a programmed learning experience in the form of formal, non-formal, and informal education, occurring both in and out of school, that lasts a lifetime and aims to optimize individual capabilities [1].

Education is a "conscious and planned effort to create a pleasant learning atmosphere for students, allowing them to actively develop their potential in spiritual, self-control, character, intelligence, noble ethics, and skills necessary for themselves and society. Education not only encompasses teaching specific skills but also something more intangible yet deeper, which is providing knowledge, assessment, and wisdom [2].

The industrial revolution has also influenced the development of the education curriculum. It requires schools to adapt to rapid technological advancements and to use increasingly sophisticated information and communication facilities to accelerate education. This curriculum change is expected to shift the focus from teachers to students [3]. In the 21st century, effective learning naturally requires teachers who can design effective learning strategies. This is because educators are now expected not only to transfer knowledge but also to condition students to have learning experiences that meet their needs [4].

A learning model is a systematically designed learning plan that forms a pattern used as a guide in planning classroom activities to make learning truly meaningful. The project-based learning model connects problems with everyday life. Projects can involve knowledge, technology, or other topics. In the 2013 curriculum, project-based learning is one of the highly recommended models for enhancing students' creativity and activity, as well as improving their skills [5]. Learning objectives, subject characteristics, and relevant media usually determine the basis for using a learning model [6].

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Project-based learning (PjBL) prioritizes problem-based learning to build relevant knowledge [7]. And project-based learning is an authentic type of learning conducted systematically to develop actual products and tasks. Upon completion of project-based learning, students will acquire independent problem-solving skills [8]. The project-based learning model helps students work independently and expand their knowledge to understand concepts, allowing them to create real products [9];[10].

Project-based learning helps students improve their problem-solving, communication, and group collaboration skills [11]. Problem-based learning or project-based learning approaches are highly recommended to enhance students' ability to create contextual work both individually and in groups [10]. Project-based learning can assist students in acquiring the skills needed in the 21st century [12]. Several studies on PjBL indicate that a student-centered approach and comprehensive learning experiences can improve education and boost student motivation [13];[14].

Learning media serves as a support in education, such as Student Worksheets (LKPD), but the use of LKPD can be impractical. Therefore, there is a need for engaging, innovative, and practical learning media like e-LKPD. The use of Electronic Student Worksheets, also known as E-LKPD, is an electronic assessment that includes feedback or grading responses from students, storage of assessment tasks, and the use of digital devices [15]. According to Santos et al., digital devices allow for the use of simulations, management of up-to-date information volumes, and enhanced interaction in learning, which makes students more engaged in the evaluation process [16]. Sorensen states that online evaluation is more efficient in terms of time, cost, and achieving evaluation objectives. Electronic assessment or E-LKPD has several advantages, such as: (1) being more flexible and accessible anytime and anywhere; (2) automatic response processing using machines; (3) efficient storage; (4) providing detailed and timely feedback; and (5) offering new question styles that encourage interaction [17].

2. Research Method

This study employs the Systematic Literature Review (SLR) method as the research methodology. This involves selecting each journal or previous study and compiling the results as references for the model or ideas to be developed. To avoid excessive bias, journal selection can be conducted by a group of people [16].

The main focus of the SLR method is as follows: (1) Planning. In this planning stage, researchers gather conclusions from several selected journals as references by formulating questions that must be answered according to the research questions (RQs). The outcome of this SLR is an analysis of each journal, demonstrating how the results are applied in practice. The formulation of RQs should adhere to five key principles: population, intervention, difference, outcome, and context applied. (2) Usage. The next stage involves searching for keywords found in abstracts, followed by selecting appropriate literature and establishing criteria as needed. These include: (1) the publication period of the journal, (2) discussion journals initiated by researchers, (3) data collected leading to traditional learning models, and (4) data collected leading to simulation learning models. At this point, journal selection requires careful consideration of articles or journals relevant to the literature study research discussion [18].

The data for this research comes from previous studies published in journals from 2020 to 2024. The literature review is based on two considerations: the literature used must have a direct relationship with the topic of the questions to be addressed (not secondary literature) and the content of the literature must be deemed valid and credible (due to clear sources).

3. Results and Discussion

The analysis results based on the two Research Questions in this study are as follows: (1) RQ1: What is the effectiveness of implementing E-LKPD based on PjBL in learning plant tissue material? (2) RQ2: What is the

effectiveness of implementing E-LKPD based on PjBL in learning plant tissue material in improving student learning outcomes?

In this literature study, the authors have categorized national and international journals that align with their research focus. They also use these as references to determine whether the model to be developed is feasible and meets the needs of students in understanding the material highlighted as the main focus of the research. A comparison table of each journal is attached as a reference in this literature study, including a discussion of the findings, as shown in Table 1.

Table 3. Student Learning Outcomes Data

No	Title	Discussion	Results
1.	The Effect of E-LKPD Assisted PJBL-STEM Learning Model on Scientific Reasoning Ability and Argumentation Performance of Class XII Science Students in Renewable Energy Materials [19]	The objective of this research is to analyze and demonstrate the impact of students' scientific reasoning abilities and argumentation performance in the PjBL-STEM learning model assisted by e-LKPD compared to a conventional model in Physics instruction for 12th-grade science students at SMA Negeri 15 Bandar Lampung. This study employs a quasi-experimental design with a pretest-posttest design.	The results of this study indicate an influence of students' scientific reasoning abilities and argumentation performance between those who participated in the PjBL-STEM learning model assisted by e-LKPD and those who followed the conventional learning model. This is evidenced by the MANOVA test results, which show a Wilks' Lambda F value of 43.208 with a significance level of 0.000.
2.	Effectiveness of e-LKPD Based on Science Process Skills Assisted Learning Management System Material Semester I Class XI SMA [20]	This study aims to develop an effective e-LKPD based on science process skills and to test its impact on student learning outcomes. The research emphasizes the importance of developing electronic teaching materials (e-LKPD) grounded in science process skills to enhance the quality of biology education in 11th-grade SMA. This study employs a research and development method based on the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation).	The research results show that the effectiveness level of the e-LKPD based on science process skills in terms of learning outcomes is 0.7, which falls into the practical category with a moderate level. The e-LKPD based on science process skills is also effective at a reasonable level. Based on these results, it is recommended that the education office at the provincial level in South Sulawesi utilize e-LKPD based on skills for biology teachers, particularly those teaching first-semester material for class XI.
3.	The Development of E-Book Based on Project Based Learning on the Plant Anatomy Structure Material [21]	This study aims to develop a plant anatomy structure e-book based on Project-Based Learning (PjBL) to train students' problem-solving skills and to assess the feasibility of the e-book both theoretically and empirically. The research discusses the importance of problem-solving abilities for students in the	The results of this study indicate that the PjBL (Project-Based Learning) based e-book on plant anatomy structure is feasible for use both theoretically and empirically. The theoretical aspect, based on validation results, falls into the very valid category, while the empirical aspect, assessed through student learning outcomes, student responses, and readability, is considered adequate

No	Title	Discussion	Results
		21st-century globalization era. 21st-century skills such as critical thinking, communication, collaboration, and creativity need to be developed through innovative learning. One of the discussed learning innovations is the use of the Project-Based Learning (PjBL) model with the plant anatomy structure e-book. This study employs the 4D development model (Define, Design, Develop, Disseminate).	based on student learning results (with an N-gain in the moderate category). The development model used is 4D.
4.	Improving Students' Science Process Skills Through PjBL Learning Assisted by Collaborative Project LKPD [22]	This study aims to improve students' science process skills in the topic of static electricity through the application of the Project-Based Learning (PjBL) model assisted by Collaborative Project Student Worksheets (LKS). The research explains that science process skills such as observation, hypothesis formulation, data collection, information analysis, and conclusion drawing are not only important for science learning but also help develop critical thinking, logic, and problem-solving abilities. This study is motivated by the fact that science process skills are taught separately from core content, leading to superficial understanding and difficulty in applying knowledge contextually. Therefore, a comprehensive approach is needed to integrate these skills into student learning.	The research results show a significant improvement in students' science process skills from the first cycle to the second cycle, with an average increase of 30.6%. The implementation of the PjBL model with LKPD also proved effective in enhancing student engagement in learning and facilitating the development of social skills.
5.	E-LKPD Based on Problem Solving as Innovative Teaching Materials to Improve The Ability to Analyze and Data Presentation on Plant Tissue [23]	The aim of this study is to analyze the effectiveness of electronic worksheets (E-LKPD) based on problem-solving in Plant Tissue to enhance the data analysis and presentation skills of high school students. This research employs a pre-experimental design with a One Group Pretest-Posttest Design. The population of the study consists of 11th-grade students in the odd semester. The sample is taken using purposive sampling, which includes one class.	The results of this study indicate that the use of electronic worksheets (E-LKPD) based on problem-solving in Plant Tissue is effective in enhancing high school students' data analysis and presentation skills. The research also shows that the majority of students' scores have reached the Minimum Completeness Criteria (KKM). There is a difference in average scores before and after learning using the problem-solving based E-LKPD, with a high N-gain improvement in data analysis skills and a moderate N-gain improvement in data presentation skills.

Several studies mentioned above, published in 2020 or earlier, will not be used for comparison with other journals; instead, they will be reviewed based on the reliability of the models previously applied. After sorting the articles, only five were found to conclude that the development of electronic worksheets (E-LKPD) based on Project-Based Learning (PjBL) is feasible and effective for use in learning, particularly in contexts that require conceptual understanding, project creation, and skill development simultaneously. For example, learning that involves practical work necessitates behavioral systems and skills explanation.

In subjects like Plant Tissue, which have complex structures, visualization and simulation are needed for better comprehension. PjBL-based E-LKPD can provide animations, videos, and interactive 3D models to facilitate this visualization.

The social system in the learning model I developed emphasizes closer interaction between teachers and students through teacher-assisted instruction, where the teacher, as the learning leader, plays a role in designing PjBL projects related to Plant Tissue, setting clear learning objectives, and crafting engaging opening questions. The teacher facilitates learning activities by guiding group discussions, providing support during project work, and supplying additional resources as needed. Progress is evaluated through observations, self-assessments, and final project presentations.

In the development of e-LKPD, teachers can take an active role or collaborate with a development team to ensure that the e-LKPD aligns with learning objectives and the designed PjBL projects. Students are active participants in the learning process, working together to complete the assigned PjBL projects. They are encouraged to engage in self-directed learning by utilizing the e-LKPD as a guide and seeking other relevant learning resources. Students apply creativity and innovation in project completion, such as in presentation design or problem-solving approaches.

Teachers play a central role in the development of e-LKPD (Electronic Student Worksheets) based on Project-Based Learning (PjBL) for the topic of Plant Tissue. They are crucial in enhancing the quality of learning related to

Plant Tissue. By understanding the roles and skills needed, teachers can create effective e-LKPD that help students achieve their learning objectives.

Teachers identify appropriate topics for plant tissue learning that align with the curriculum and desired learning goals. They design relevant PjBL projects, set engaging opening questions, and determine the steps for project implementation. Teachers can develop the e-LKPD themselves or collaborate with a development team to ensure it aligns with the designed PjBL project.

The e-LKPD should include step-by-step guidelines, relevant digital resources, and interactive worksheets. PjBL-based learning helps students develop essential 21st-century skills, such as critical thinking, problem-solving, and collaboration skills.

4. Conclusion

From the various scientific articles researched and compared, it can be concluded that several studies developing electronic learning media (e-LKPD) based on Project-Based Learning (PjBL) are feasible and effective for use in education. The Project-Based Learning (PjBL) model is chosen because it helps students enhance problem-solving skills, communication, and collaboration within groups. PjBL also aligns with the demands of 21st-century education. This research shows that the use of e-LKPD can improve students' thinking skills and is effective in learning about Plant Tissue. Furthermore, the implementation of e-LKPD based on PjBL significantly enhances student learning outcomes, as evidenced by improved analytical and presentation skills, enabling students to meet minimum completeness criteria. It is hoped that the use of PjBL-based e-LKPD will assist teachers in creating engaging learning media and enhance student activity and creativity.

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