available at http://ejournal.unp.ac.id/students/index.php/pek/index
EcoGen
ISSN 2654-8429 (Online)
Jurnal Ecogen
Universitas Negeri Padang
Vol. 8 No. 1 2025
Page 62-74

Development of Interactive E-LKPD Based on Process Oriented Guided Inquiry Learning (POGIL)

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ARTICLE INFO

Received 12 Februari 2025
Accepted 20 Maret 2025
Published 24 Maret 2025

Keywords: E-LKPD, POGIL, ADDIE, Learning outcomes

DOI:
http://dx.doi.org/10.24036/jmpe.v8i1.17118

ABSTRACT

This study aims to determine (1) the criteria for developing E-LKPD teaching materials designed to evaluate economics learning based on Process Oriented Guided Inquiry Learning (POGIL) and (2) their effectiveness in improving students' academic performance, evaluated through pre-tests and post-tests. This study adopts development research design utilizing the ADDIE model, comprising five stages: analyze, design, development, implementation, and evaluation. The product trial involving 62 grade XI students at SMAN 18 Surabaya was executed using a non-equivalent control group design. The data were analyzed applying the N-Gain Score Test and Independent Sample t-test. The results indicate that the average validation score from material and media experts was 86.7%, categorized as "Very Feasible". Student responses averaged 89%, and teacher responses averaged 90.5%, both deemed as "Very Practical". The N-Gain Score test yielded a score of 77.2%, categorized as effective, and the Independent Sample t-test indicated a significance level of 0.001 < 0.05. Therefore, it can be concluded that the E-LKPD based on POGIL is effective in enhancing students' learning outcomes.

INTRODUCTION

A major challenge in 21st-century education is ensuring the effectiveness of the learning process amidst the rapid dynamics of globalization. In response, technology has become a crucial facilitator, providing opportunities to improve educational quality (Made *et al*., 2024). As technological advancements continue to accelerate, the education sector is increasingly encouraged to integrate digital tools into both management and instructional practices, thereby optimizing learning outcomes. This development highlights the pivotal role of technology in advancing the educational setting (Amran *et al*., 2023).

The implementation of the Merdeka Curriculum in Indonesia is crucial for preparing students with the competencies required for adjusting to swift global transformations through

innovative educational approaches and strategies (Rosa *et al*., 2024). A key strategy for enhancing learning outcomes is the integration of technology. Nuridayanti *et al*. (2023) underlined the need of incorporating technology into the Merdeka Curriculum to enhance learning effectiveness by broadening students' access to diverse sources of information. The successful implementation of the Merdeka Curriculum requires comprehensive support, comprising continuous professional development for educators, access to pertinent teaching resources, and the creation of innovative educational instruments (Arisanti, 2022). Lutfiana (2021) further emphasized the necessity of strengthening instructors' competencies in managing technology-enhanced learning and designing innovative instructional media. Considering the extensive variety of educational media, educators must judiciously choose tools that most effectively correspond to the requirements of the teaching and learning process. This is reinforced by Wulandari *et al.* (2023) who highlighted that appropriately selected learning media may enhance student engagement, foster motivation, facilitate direct interaction with the environment, and promote self-directed learning aligned with students' abilities and interests.

Previous researches have extensively analyzed the selection of innovative, technology-integrated educational media. According to Harahap & Siregar (2020), technology-based learning media can greatly increase student involvement in the learning process when they are aligned with the characteristics of contemporary learners. Contemporary learners, often referred to as Generation Z, have been immersed in a digital environment where technology is an integral aspect of their daily lives. Bagdi *et al*. (2023) highlighted that Generation Z prefers audiovisual-based learning media and readily accessible electronic books as primary learning resources, while simultaneously prioritizing hands-on practice and experiential learning methods.

E-LKPD is a flexible alternative learning media that effectively addresses students' learning needs (Izzah *et al*., 2023). Research demonstrates that E-LKPD markedly improves learning performance by aiding problem-solving tasks, enabling voicing of opinions, and enhancing critical thinking abilities (Novendra *et al*., 2023). Futhermore, Saputri (2025) stated that E-LKPD can present complex concepts and issues in a more comprehensible manner, adhere to curricular standards, and offer greater flexibility compared to conventional LKPD. This is especially pertinent to the learning media preferences of Generation Z students. The integration of E-LKPD in the learning process enhances dissemination of knowledge and fosters active student participation through interactive features that facilitate a more profound examination of the subject matter. Munawaroh & Sholikhah (2022) identified E-LKPD as an effective assessment tool, particularly when combined with an appropriate instructional model.

Several studies indicate that the adoption of E-LKPD remains limited across various educational institutions. A primary challenge is the lack of interaction and compelling design, which may lead to diminished student engagement in the learning process. To address these limitations, innovative approaches are necessary to enhance its development (Hanum & Amini, 2023). In line with recent research developments, Nianti *et al*. (2022) emphasized that E-LKPD should be designed to be both engaging and interactive to boost students' learning motivation, promote active involvement, and create a more meaningful learning experience. Therefore, in order to accommodate students' preferred methods of learning, the deevelopment of E-LKPD must have interactive features, well-structured visual design components, and pertinent

technologies. This is especially significant for Generation Z, who possess extensive familiarity with digital technology in their everyday lives.

A preliminary survey was conducted utilizing questionnaires and participatory interviews with grade XI educators and students at a senior high school in Surabaya. The findings revealed that 80% of respondents perceived the implementation of the Merdeka Curriculum as providing substantial flexibility for both educators and learners in the educational process. Teachers actively endeavor to implement effective instructional models and learning media that correspond with student characteristics. Furthermore, to enhance students' comprehension, educators incorporate structured problem-solving exercises as an evaluative strategy to reinforce conceptual understanding. However, in Economics subjects, 55% of grade XI students have yet to meet the Criteria for Achievement of Learning Objectives (KKTP). Many students reported that their comprehension remains predominantly theoretical, with limited awareness of its practical applications in real-world contexts. This misalignment contradicts the core principles of the Merdeka Curriculum, which prioritizes meaningful learning ensuring that students achieve cognitive mastery of concepts while also cultivating the capacity to connect them to real-life experiences and apply them in diverse contexts (Kurniawati & Putri, 2023). Despite the increasing emphasis on technology integration in education, E-LKPDs have yet to be adopted in economics instruction, leading to a missed opportunity for technology to augment student understanding through interactive and contextual learning experiences. These findings underscore the imperative to develop innovative learning media integrated with suitable instructional models to cultivate a deeper and more contextual comprehension of economic concepts.

The Process-Oriented Guided Inquiry Learning (POGIL) model is an educational approach that prioritizes learning as a process, while fostering students' collaborative abilities and critical thinking skills. Zammi *et al*. (2021) identified POGIL as a student-centered educational framework focusing on guided inquiry and group collaboration. Empirical studies have demonstrated that this method markedly improves critical thinking, collaboration, and overall student learning outcomes (Gao *et al*., 2024). Prihatami (2020) further outlined several advantages of the POGIL model, including (1) facilitating independent knowledge construction, (2) its applicability across diverse educational tiers, (3) supporting the development of process and communication skills, (4) enabling coverage of a broad range of subject matter, and (5) enhancing students' problem-solving abilities. Considering these features, POGIL serves as an exceptionally efficient pedagogical framework for cultivating essential 21st-century competencies among learners.

Numerous research have investigated the integration of the POGIL model with E-LKPD. Rianajni *et al*. (2024) discovered that a POGIL-based E-LKPD on covalent bonding significantly improved students' learning independence. Similarly, Tyas & Novita (2023) reported that the application of a POGIL-based E-LKPD in the study of reaction rates significantly improved students' critical thinking abilities. In alignment with these findings, Putri & Rahayu (2023) revealed that a POGIL-based E-LKPD also contributed to the development of critical thinking skills in redox reaction topics. Current studies predominantly emphasize the efficacy of POGIL-based E-LKPD in scientific disciplines. Nevertheless, limited studies have explored its application in Economics education. Considering that inquiry-based learning methodologies like POGIL

possess considerable potential to improve critical thinking, conceptual comprehension, and overall educational results in economics, additional research is necessary. This work aims to fill this gap by creating a POGIL-based E-LKPD for economics education, thereby enhancing learning innovation and broadening the use of POGIL in non-scientific disciplines.

METHODS

This study adopts the ADDIE model as its developmental framework within a Research and Development (R&D) approach. The ADDIE model comprises five systematic stages: analyze, design, development, implementation, and evaluation (Rahma *et al*., 2023). The research procedure adheres to these sequential phases, integrating iterative refinements at each stage to enhance the development process (Novitasari & Puspitawati, 2022). A visual representation of the ADDIE model and its application in this study is illustrated in Figure 1.

Figure 1. Stages of the ADDIE Model

Source: Adapted from Hidayat & Nizar (2021)

This study utilized a quasi-experimental design featuring a non-equivalent control group approach, comparing pretest and post-test scores of both the experimental and control groups. To ensure the selection of participants specific criteria, the researchers employed a non-probability sampling method, specifically using a purposive sampling technique (Soegiyono, 2013). The sampling criteria were established based on the average scores from the Final Semester Summative Assessment (SAS) in Economics. Based on these criteria, Class XI-5, comprising 37 students, was assigned as the control group, while Class XI-2, consisting of 25 students, was allocated as the experimental group.

The research instruments included an expert validation sheet, pretest and post-test assessments, and student and teacher response questionnaires. The expert validation sheet was used to evaluate the subject matter validity and interactivity of the POGIL-based E-LKPD. The pretest and post-test assessments measured changes in students' learning outcomes following the implementation of the POGIL-based E-LKPD. Additionally, the student response questionnaire appraised the practicality of the media, whilst the educator response questionnaire evaluated its feasibility.

This study utilized two types of data: qualitative and quantitative. Qualitative data were gathered through validation by material and media experts, who provided critiques and recommendations regarding the feasibility of the developed product, alongside responses from questionnaires filled out by students and teachers. Simultaneously, quantitative data were

obtained via validation scores assigned by material and media experts, responses from student and teacher questionnaires measured by a Likert scale, and students' pretest and post-test scores.

The data collection techniques included both test-based methods (pretest and post-test) and non-test methods (documentation). Data analysis was conducted using a qualitative descriptive approach to classify information from expert validation and questionnaires completed by students or teachers. Furthermore, quantitative descriptive statistical analysis was applied to process pretest and post-test scores, providing an overview of the outcomes and noted alterations. Additionally, pretest and post-test data were analyzed using the N-Gain Score Test and the Independent Sample t-Test to measure the effectiveness of the learning media and to examine the research hypothesis (Putri, 2024; Rahmi *et al*., 2021).

RESULTS AND DISCUSSION

Results

The first step of developing POGIL-based E-LKPD is known as the analysis (analyze) phase, and it consists of assessing learning requirements and identifying challenges that emerge during the learning process. This phase involves three principal analyses: (1) competency analysis, (2) analysis of the needs of students, educators, and teaching materials, and (3) analysis of the subject matter's facts, concepts, and procedural aspects (Leny *et al*., 2024). The results of the Final Semester Summative Assesment (SAS) competency analysis in Economics indicate that students' learning difficulties are primarily attributed to the lack of appropriate reading materials and insufficient opportunities for independent practice. Consequently, students frequently encounter difficulties with knowledge retention and are prone to forgetting topics they have previously studied.

An analysis of student, teacher, and teaching material needs uncovers a disparity between students' learning requirements and the existing instructional models. The implementation of differentiated learning fails to appropriately handle variations in students' cognitive ability. Moreover, the existing instructional materials are not entirely understood by students, leading to 73% of them pursuing additional resources to improve their comprehension of the subject matter.

Furthermore, an analysis of the facts, concepts, and procedures pertinent to the subject matter was conducted to define the learning objectives in the POGIL-based E-LKPD. According to the questionnaire results, 65.8% of students reported that the topic Monetary and Fiscal Policy is relatively difficult, as it requires a strong conceptual understanding. This signifies the necessity for a pedagogical style that actively involves students in collaborative group activities, allowing them to investigate issues more thoroughly through peer discussion. According to this analysis, creating a POGIL-based E-LKPD for the economics topic of Monetary and Fiscal Policy is crucial to meeting learning goals and improving the standard of education for high school students in Grade XI.

The subsequent phase in the development process is the design stage. At this stage, the initial draft (Draft I) of the POGIL-based E-LKPD was developed, comprising a front cover, instructional guidelines, learning objectives, a material summary, an interactive quiz, case study inquiries, an evaluation section, a learning reflection, and a bibliography. The initial draft was

developed using Microsoft Word, after which the design was further refined using Canva. The design of the POGIL-based E-LKPD was adhered to the 2014 National Education Standards Agency (BSNP) guidelines on teaching material assessment instruments and the syntax of the POGIL learning model, which consists of orientation, exploration, concept discovery, application, and evaluation (Laliyo *et al*., 2022). To reinforce the learning model's syntax, supplementary elements were integrated to facilitate students' comprehension at each stage of the POGIL-based E-LKPD. The available features include EcoLearn, EcoQuest, EcoCase, EcoPlan, EcoPresent, and EcoEval. Their functions are outlined in Figure 2.

Features	Usability
EcoLearn	Contains facilities for identifying basic concepts by presenting teaching materials in the form of articles, videos, and relevant readings.
EcoQuest	Used to develop analytical and problem-solving skills through exploration of concepts in case studies.
EcoCase	This feature reinforces previous concept discoveries with a game element to boost student excitement.
EcoPlan	To develop students' applicative thinking skills in applying concepts to real situations.
EcoPresent	This feature is expected to improve students' oral communication skills, argument organization, and self-confidence.
EcoEval	Contains facilities for students to self-evaluate and understand the material that has been learned.

Figure 2. Features of the POGIL-Based E-LKPD

Source: Personal documentation

Upon finalization of the draft design, it was downloaded and preserved in PDF format. To transform the POGIL-based E-LKPD into an interactive electronic teaching material, the draft was converted using the Hyzine Flipbook platform, resulting in a final version accessible through a link. In addition to integrating interactive features, the POGIL-based E-LKPD also includes supplementary material summaries, pertinent case study questions, additional reading resources, and a comprehensive navigation system that enables users to access selected links directly.

Additionally, throughout the development stage, the POGIL-based E-LKPD undergoes a validation procedure by both material and media experts. The validation results serve as a benchmark for revising the POGIL-based E-LKPD before to implementation. The eligibility criteria state that the POGIL-based E-LKPD is considered feasible for use if it achieves a score of ≥ 61% and highly feasible if it attains a score of ≥ 81% (Cholifah & Novita, 2022). Table 1 presents the validation results from material and media experts on the POGIL-based E-LKPD.

Table 1. Validation Results from Material and Media Experts

Numb	Aspect	Result		Average Score	Interpretation
		Validator 1	Validator 2		
1	Material	84,1%	86,1%	85,1%	Very Feasible
2	Media	83,6%	92,9%	88,3%	Very Feasible
Overall Average				**86,7%**	**Very Feasible**

Source: Primary data (2025)

Based on the material validation results presented in Table 1, the assessment by material experts yielded a score of 85.1%, categorizing it as "Very Feasible." Simultaneously, the evaluation by media experts resulted in a score of 88.3%, also classified as "Very Feasible." The cumulative average validation score from both experts was 86.7%, meeting the "Very Feasible" criteria. These

results correspond with the feasibility interpretation criteria established by Cholifah & Novita (2022), which define a score of ≥ 81% as "Very Feasible". Therefore, the POGIL-based E-LKPD is considered highly suitable for application. Based on the assessment results, it can be concluded that the POGIL-based E-LKPD meets quality standards and is appropriate for implementation in the learning process. Following the validation stage and the incorporation of expert suggestions and feedback, the POGIL-based E-LKPD was revised into Draft II, which was then prepared for field testing. The conclusive design of the POGIL-based E-LKPD is shown in Figure 3 and is accessible at bit.ly/elkpdpogil4.

Figure 3. Example of the POGIL-Based E-LKPD Interface

Source: Personal documentation

At the implementation stage, individual trials involving five students and small group trials with ten students were conducted prior to the large-group trial (Herdianto, 2023). The individual and small group trials were carried out online by distributing the POGIL-based E-LKPD in digital format through a shared link, while student responses were gathered using a Google Form questionnaire. The individual trial yielded an average score of 78.5%, categorizing it as "Practical." During this step, students proposed the simplification of intricate language to improve readability and understanding. Meanwhile, the small group trial achieved an average score of 83%, categorizing it as "Highly Practical". Student feedback in this phase primarily focused on correcting typographical errors. The positive results from these two pilot tests indicate promising prospects for further refinement and the subsequent large-group trial of the POGIL-based E-LKPD.

In the large-group trial, students in both the experimental and control classes first took a pretest to assess their initial understanding of the material to be studied. The pretest served as a baseline evaluation prior to the implementation of instructional interventions.

Following the pretest, students were introduced to fundamental concepts of Monetary and Fiscal Policy. Subsequently, the experimental class received treatment using the POGIL-based E-LKPD during the second and third meetings, while the control class utilized conventional E-LKPD materials. Upon concluding the designated E-LKPD activities, both classes took a post-test to evaluate any improvements in their understanding and learning outcomes.

The pretest and post-test results were then analyzed, and hypothesis testing was performed. Once the data from both classes were obtained, prerequisite analyses—including normality and homogeneity tests—were conducted. The results of the normality test are presented in Figure 4.

Group	Shapiro-Wilk			Description
	Statistic	Df	Sig.	
Experimental	0,971	25	0,669	Normal
Control	0,954	37	0,132	Normal

Figure 4. Normality Test Results

Source: Primary data (2025)

The results indicate that the significance level for the experimental class is 0.669, while for the control class, it is 0.132. According to the normality test criteria, the null hypothesis (H_0) is accepted if the significance value is $\geq \alpha$ with $\alpha = 0{,}05$ (Hayati *et al*., 2022). Based on these results, it can be concluded that the data are normally distributed. Subsequent to the normality test, a homogeneity test was performed to evaluate the equality of variances between the two groups. The outcomes of the homogeneity test are presented in Figure 5.

Levene Statistic	df1	df2	Sig.	Description
3.270	1	60	0,076	Homogeneous

Figure 5. Homogeneity Test Results

Source: Primary data (2025)

The table above indicates that the significance value for the homogeneity test is 0.076. Based on the homogeneity test criteria, the null hypothesis (H_0) is accepted if significance (Sig.) $\geq \alpha$, where α = 0.05. These results validate that the data satisfy the homogeneity assumption. Following the confirmation of normality and homogeneity, the next step involves hypothesis testing using a t-test to ascertain whether the proposed statement can be accepted or rejected (Noor *et al*., 2023). The hypotheses formulated for this study are as follows: the null hypothesis (H_0) states that there is no substantial disparity in average student learning outcomes between the experimental and control classes, while the alternative hypothesis (H_1) suggests that a significant difference exists between the two groups. Due to the unpaired nature of the data, the Independent Sample T-Test was employed for hypothesis testing (Wahyudi *et al*., 2023). The results of the Independent Sample T-Test are presented in Table 2.

Table 2. Independent Sample T-Test Results

Group	T_{table}	Df	$T_{calculated}$	Sig (2-tailed)	Mean Difference
Experimental Control	3.270	60	3.975	0.001	8.784

Source: Primary data (2025)

Table 2 reports a two-tailed significance value (Sig.) of 0.001, which is below the 0.05 criterion. This finding indicates a statistically significant difference in learning outcomes between the experimental and control classes. Consequently, it can be concluded that the POGIL-based E-LKPD significantly enhances students' learning results in comparison to the conventional E-LKPD. The alternative hypothesis (H_1) is accepted, whereas the null hypothesis (H_0) is rejected. To further evaluate the effectiveness of the POGIL-based E-LKPD, an N-Gain Score test was conducted. The results of this analysis are presented in Table 3.

Table 3. N-Gain Score Test Results

Group	*N-Gain Percentage*	Category
Experimental	77.2%	Effective
Control	40.2%	Less Effective

Source: Primary data (2025)

Based on the results of the N-Gain Score Test, the experimental class achieved an average N-Gain Score of 77.2%, which falls into the "Effective" category. In contrast, the control class obtained an average N-Gain Score of 40.2%, classified as "Less Effective." These findings indicate that the implementation of the POGIL-based E-LKPD is effective in enhancing students' learning outcomes.

The evaluation stage marks the concluding phase of the ADDIE research model (Putri, 2024). After conducting the pilot test and analyzing the pretest and post-test results, the findings confirmed that the POGIL-based E-LKPD significantly improves students' learning outcomes. To further assess its applicability in the learning process, a questionnaire was administered to the students. The results of their responses regarding the use of the POGIL-based E-LKPD are presented in Table 4.

Table 4. Results of Student Response Questionnaire

No.	Aspect	Percentage	Category
1	Functionality	91.5%	Very Practical
2	Usefulness	95%	Very Practical
3	Ease of Use	83%	Very Practical
4	Satisfaction	94%	Very Practical
Average Score		90.8%	Very Practical

Source: Primary data (2025)

Based on the results presented above, the practicality assessment of the POGIL-based E-LKPD yielded an overall score of 90.8%, categorizing it as "Very Practical." The four evaluated aspects—functionality, usefulness, ease of use, and satisfaction each obtained a percentage score ≥ 81%, which, according to the criteria established by Cholifah & Novita (2022), falls within the "Very Practical" category. These results clearly demonstrate that the POGIL-based E-LKPD is highly practical and well-suited for use in the learning process. Alongside student replies, economics educators also provided feedback on the feasibility and effectiveness of the POGIL-based E-LKPD. Table 5 presents the results of the feasibility assessment based on teacher responses collected through a questionnaire.

Table 5. Results of Teacher Response Questionnaire

No.	Aspect	Percentage	Category
1	Effective	90.2%	Very Practical
2	Interactive	89%	Very Practical
3	Efficient	95%	Very Practical
4	Creative	88%	Very Practical
Average Score		90.5%	Very Practical

Source: Primary data (2025)

Based on the final results, the average educator response score attained 90.5%, categorizing the POGIL-based E-LKPD as "Very Practical." The data indicate that the efficiency metric reached a percentage of 95%, demonstrating that the POGIL-based E-LKPD effectively integrates all learning activities into a single, cohesive instructional unit. This characteristic improves its efficiency as an educational instrument, as it comprehensively incorporates key elements such as instructional materials, exercises, assignment submissions accessible at any time, interactive quizzes, and, most importantly, prompt feedback on completed tasks.

Discussion

Based on the results of expert validation and product trials, the POGIL-based E-LKPD is deemed highly feasible and can serve as an alternative learning resource to support differentiated and engaging instruction for students. In the subject matter expert assessment, the linguistic aspect received the highest validity index of 92.4%, indicating that the subject matter is presented in clear, communicative, and interactive language that effectively stimulates students' curiosity. Meanwhile, in the media expert evaluation, the accessibility component attained the highest validity percentage, averaging 90.8%, which falls within the "Very Feasible" category. These findings align with the study by Anggraeni *et al*. (2024) which highlighted that the majority of students favor E-LKPDs that are accessible on many devices, including computers, tablets, and smartphones. The POGIL-based E-LKPD meets this expectation by offering high accessibility, enabling students to conveniently access learning materials according to their needs. The thorough validation results from material and media experts yielded an average score of 86.7%, interpreted as "Very Feasible". Additionally, the development of this POGIL-based E-LKPD has been carefully aligned with the content and competency standards specified in the Merdeka Curriculum, ensuring that it meets the established criteria for effective learning implementation.

Before being tested on a large group, the product was initially assessed through individual and small-group trials. This approach aligns with the findings of Syarlisjiswan *et al*. (2024) who emphasized that feedback obtained from these preliminary trials serves as a critical foundation for researchers to refine and enhance the product before proceeding to large-scale testing. The results of the large-group trial demonstrated significantly favorable responses. The POGIL-based E-LKPD demonstrated a more interactive and engaging functionality compared to conventional LKPDs, fostering greater student enthusiasm in understanding the material and completing assigned tasks. These findings are consistent with the study by Heriyanto *et al*. (2024) which determined that electronic LKPDs are more pedagogically effective and appealing for students compared to traditional paper-based equivalents. Moreover, electronic LKPDs offer the advantage of offline accessibility via computers or laptops, thereby reducing students' financial burden in accessing learning materials (Kont, 2020).

The students' learning outcomes demonstrated significant improvement following the implementation of the POGIL-based E-LKPD, as indicated by the findings of the Independent Sample T-Test and N-Gain Score analysis. This educational instrument effectively facilitates student engagement, addresses spatial and temporal limitations, promotes independent learning, and enables self-evaluation of learning progress. Based on these findings, it can be concluded that the developed POGIL-based E-LKPD is very effective and functions as a viable

instructional material in technology-enhanced learning environments. Specifically, it supports student achievement in Economics education, particularly in the topic of Monetary and Fiscal Policy for Grade XI SMA students.

CONCLUSION

The research findings on the development of the POGIL-based E-LKPD demonstrate that the product is very feasible for implementation, as evidenced by an average expert validation score of 86.7%. Student responses to the POGIL-based E-LKPD yielded a score of 90.8%, categorizing it as "Very Practical". Additionally, subject educators rated the product with a score of 90.5%, interpreting it as "Very Practical". The hypothesis test results validated the acceptance of H_1 and rejection of H_0, while the effectiveness test obtained a score of 77.2%, indicating a sufficient level of effectiveness in enhancing student learning outcomes.

This study possesses some limitations. First, the development of the POGIL-based E-LKPD was designed specifically to fit the needs and context of a particular high school in Surabaya, suggesting that it may not be entirely suitable to schools with different characteristics. Second, its effectiveness was tested in a limited trial conducted at a single school. To ensure its broader applicability and effectiveness, further extensive experiments are required.

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