Development of STEAM-PJBL Based IPAS LKPD to Improve Students' Science Literacy

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Abstract: This study aims to develop Student Worksheets (LKPD) for Natural and Social Sciences (IPAS) based on the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach and the Project Based Learning (PjBL) model to improve the science literacy of fourth-grade elementary school students. The research method used was Research and Development (R&D) with the 4D development model (Define, Design, Develop, Disseminate). The test subjects consisted of 20 students and 3 educators at an elementary school in Bandar Lampung City. The results of validation by media, language, and material experts show that the developed LKPD is considered highly valid with an average Aiken's V coefficient above 0.90. Practicality tests show that the LKPD is rated "Very Practical" by educators (86.1%) and students (86.6%), based on aspects of readability, ease of use, visual appeal, and meaningful content. Effectiveness testing was conducted through pretest and posttest science literacy tests, with results showing an increase in the average score from 53.00 to 81.00 and an n-Gain value of 0.65, which is classified as moderate. It can be concluded that STEAM-PjBL-based LKPD IPAS is suitable for use in learning because it meets the aspects of validity, practicality, and effectiveness. This product has the potential to be an innovative and contextual learning medium in supporting the strengthening of elementary school students' science literacy.

Introduction

The 21st century is an era in which technology is developing rapidly and affecting almost all aspects of life, including education. To create superior human resources capable of competing globally, a country's society must adapt to advances in science and technology (Pratiwi et al., n.d.). In response to these challenges, the Indonesian government has implemented the Merdeka Curriculum policy through Permendikbudristek Number 12 of 2024, which emphasizes the importance of mastering 21st-century competencies, such as digital literacy, science literacy, numeracy, and reading literacy. One type of literacy that is increasingly crucial in facing global issues is science literacy. This is because progress does not only bring positive impacts, but also causes various problems such as global warming, energy crises, and environmental damage (Rahayu & Maryani, 2023). Therefore, a strong understanding of scientific concepts is needed so that the public can make decisions based on accurate information. As stated by (Reddy et al., 2022), science literacy is not only about

understanding scientific knowledge but also the ability to apply scientific information in everyday life to address global issues critically and responsibly.

Scientific literacy is defined as the ability to understand scientific facts, the relationship between science, technology, and society, and apply that knowledge to solve real-life problems (Cerna et al., 2021; Effendi et al., 2021). Improving scientific literacy certainly requires a learning approach to be more effective, one of which is using the STEAM-PjBL approach. STEAM stands for Science, Technology, Engineering, Arts, and Mathematics, which is an adaptation of the more commonly known term, STEM. In 1986, the National Science Foundation (NSF) of the United States first used STEM in its report "Science, Mathematics, and Engineering Education," marking the beginning of the use of the term STEM (Liao et al., 2022). Students who participate in STEAM learning are able to explore all of their skills, search for information from various sources, communicate with others, and produce something of economic value (Choirunnisa et al., 2023). The application of the STEAM approach combined with the PjBL model can improve teaching and learning activities because of its characteristics that have the potential to facilitate 21st-century skills, which are very important for overcoming the challenges of education in the 21st century (Iaskyana & Triatna, 2022; S. Lestari, 2021; Undari & Pascasarjana Pendidikan Dasar, 2023).

The results of the needs analysis conducted at SDN 2 Talang in Teluk Betung Selatan District found that the science literacy of fourth-grade elementary school students needs to be developed and improved. The average score was 45. This data shows that students' science literacy is low. The low science literacy of students in IPAS learning is one of the reasons for researchers to develop and improve students' science literacy. The results of the needs analysis conducted on April 11-20, 2025, through a questionnaire distributed to 104 educators in Lampung Province found that students' science literacy needs to be improved, with 92.3% or 96 educators agreeing with this improvement. In addition, 76% or 79 educators experienced difficulties in training science literacy, even though 56.7% or 59 educators had used LKPDs aimed at improving students' science literacy. This is possible because the LKPDs that are widely circulated and used in schools today are general in nature and only contain summaries of the material.

As a learning medium, LKPD has several components or elements that make it suitable for use as a learning medium. LKPD is a means to assist and facilitate teaching and learning activities so that effective interaction between students and educators can be established, thereby increasing student activity in improving learning achievement (Ranti and Usmeldi, 2019). LKPD has many advantages, namely making it easier for educators to carry out learning, and students will learn independently and learn to understand and carry out written assignments (Marshel and Ratnawulan, 2020).

The learning objectives and indicators presented by educators can be achieved by implementing the best possible learning tools. The objectives can be achieved through the activities of educators when explaining the material, the activities of students in learning using LKPD, listening to messages through the LKPD used, and all learning resources that are useful for creating perfect learning. Therefore, learning tools must be designed with consideration of adequacy, ease, and attractiveness for students so that learning is easy. Another objective is to improve students' science literacy.

Research Method

This study uses a Research and Development (R&D) approach with a 4D development model (Define, Design, Develop, Disseminate) developed by (Thiagarajan, 1974).
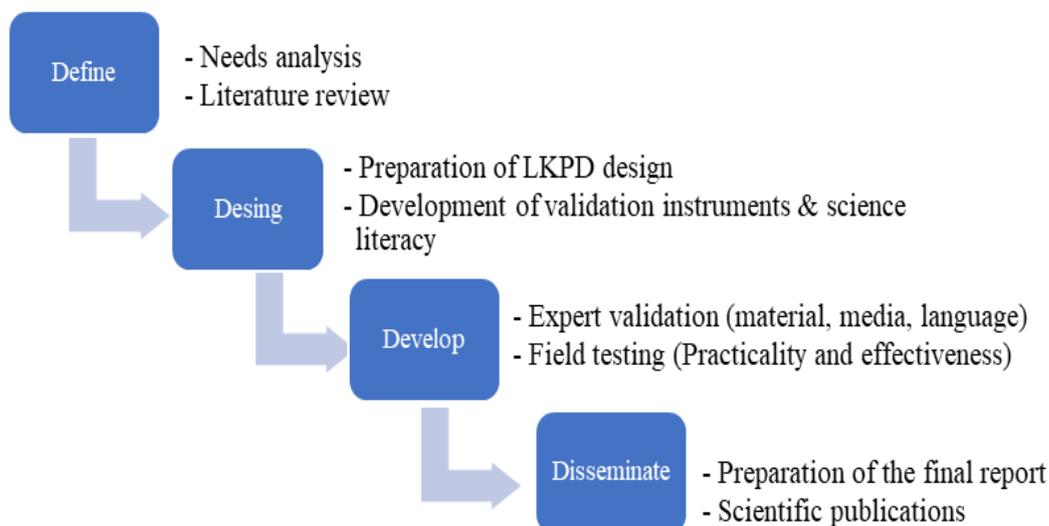

Figure 1. 4D Research Flow Chart adopted from (Thiagarajan, 1974)

The population in this study was all fourth-grade elementary school students in Talang Village, South Teluk Betung District, Bandar Lampung City, namely: SD Negeri 1 Talang, SD Negeri 2 Talang, and SD Negeri 4 Talang. The research sample was determined using purposive sampling, taking into account active involvement in IPAS learning and willingness to participate in the product trial process (Hossan et al., 2023). The sample consisted of all fourth-grade students in Class A at SD Negeri 2 Talang, totaling 20 students, and was supported by educators relevant to the trial implementation.

Data Analysis Techniques. Beginning with a preliminary test of the instrument to demonstrate the level of validity or accuracy of an item. An item is considered valid if it can be used to measure what it is intended to measure. After testing, the validity of the questions is calculated using the product moment formula (Hidayati et al., 2023). This is followed by a reliability test of the instrument. A reliable instrument is one that, when used several times to measure the same object, will generally produce the same data. To measure the consistency of the questions, the Cronbach's alpha formula is used. 2.1.1 The validity and practicality of PBL-based animated learning media is determined by conducting an expert validation analysis using the formula: $V = \Sigma s/(n\,(c-1))$ $s = r - lo$. This is followed by an analysis of the responses of educators and students. The results of the educator response questionnaire are analyzed using descriptive percentage analysis with the Likert scale formula: $P = \frac{n}{N} \times 100\%$.

Effectiveness Test to measure the effectiveness of the media by conducting an analysis in the form of a normality test on the SPSS program through a one-sample Kolmogorov-Smirnov test, significance (α) > 0.05 data is said to be normally distributed. Then, a homogeneity test is conducted using a one-way ANOVA test with the help of the SPSS program. Significance (sig) > the specified alpha level, which is 0.05. Then, to determine the extent of improvement in students' science literacy, an n-Gain value analysis is performed, followed by a paired sample t-test. The paired sample t-test calculation is performed using the t-test formula in SPSS, with decisions based on the criterion (sig) > 0.05.

Result and Discussion
Result

In media expert validation, there are three indicators, namely devices, visual communication, and media characteristics. The results of material expert validation are shown in Table 1 below:

Table 1. Media Validation Results

Aspects assessed	Aiken's number	Aiken's coefficient criteria
Device	0,8438	Very Valid
Visual Communication	0.9444	Very Valid
Media Characteristics	0,9375	Very Valid
Average	0,9086	Very Valid

The table above shows that the results of the media expert team's validation test obtained an average score of 0.9086, which falls within the category of > 0.84 and is considered highly valid. Therefore, it can be concluded that the STEAM-PJBL-based LKPD for fourth grade elementary school students with plant-related material is highly valid in terms of media. The device aspect scored 0.8438 and fell into the highly valid category, the visual communication aspect scored 0.9444 and fell into the highly valid category, and the media characteristics aspect fell into the highly valid category with a score of 0.9375. Based on these findings, it can be seen that the STEAM-PJBL-based LKPD developed meets all media indicator criteria with a highly valid score, so it can be concluded that the STEAM-PjBL-based LKPD is an appropriate medium for improving science literacy.

There are four indicators for linguistic validation: clarity, linguistic appropriateness, suitability, and use of terminology. The results of material expert validation are shown in Table 2 below:

Table 2. Language Validation Results

Aspects assessed	Aiken's number	Aiken's coefficient criteria
Clarity	0,9167	Very Valid
Language	0,8438	Very Valid
Appropriateness	1,0000	Very Valid
Use of Terms	1,0000	Very Valid
Average	0,9401	Very Valid

The language validation results obtained an average score of 0.9401 and were considered highly valid. This average score was obtained from the clarity aspect, which received an average score of 0.9167 and was categorized as highly valid; the linguistic aspect received an average score of 0.8438 and was categorized as highly valid; the aspect of suitability for student development received an average score of 1.000 and was categorized as highly valid; and the aspect of use of terms and symbols obtained an average score of 1.000, categorized as highly valid. Based on this data, it can be concluded that the STEAM-PjBL-based LKPD developed in terms of language can be used to improve science literacy.

There are four indicators for content expert validation, namely curriculum, content, presentation, and implementation. The results of content expert validation are shown in Table 3.

Table 3. Material Validation Results

Aspects assessed	Aiken's number	Aiken's coefficient criteria
Curriculum	0,9583	Very Valid
Content	0,8571	Very Valid
Presentation	0,8929	Very Valid
Implementation	0,9167	Very Valid
Average	0,9063	Very Valid

Table 3 shows the results of expert validation, which obtained an average score of 0.9063 with a criterion of highly valid. In expert validation, there are four focus aspects, namely curriculum, content, presentation, and implementation. In the curriculum aspect, the average score was 0.9583, which is categorized as highly valid. In the content aspect, the average score was 0.8571, which is also categorized as highly valid. In the presentation aspect, the average score was 0.8929, which is categorized as highly valid. Meanwhile, in the implementation aspect, the average score was 0.063, which is categorized as highly valid.

The results of the effectiveness test on 20 students showed individual n-Gain scores ranging from 0.50 to 1.00. The total n-Gain was 13.00, giving an average n-Gain of 0.65. Based on Hake's classification, this value falls into the moderate category, indicating that STEAM-PjBL-based IPAS worksheets are quite effective in improving students' science literacy. These findings show that the STEAM-PjBL approach in worksheets not only improves understanding of IPAS concepts but also encourages scientific, reflective, and evidence-based problem-solving skills. This data provides a basis for the feasibility of using the developed LKPD in IPAS learning in elementary schools.

Discussion

In this study, validation was carried out by three groups of experts, namely media experts, language experts, and subject matter experts. Each group of experts assessed the STEAM-PjBL-based IPAS LKPD using a 1–4 Likert scale instrument, which was then analyzed using Aiken's V coefficient. Aiken's V analysis was used to measure the level of agreement among experts on each indicator assessed, with values ranging from 0 to 1. The closer the value is to 1, the higher the validity of the device being tested (Noviana et al., 2023; Putri et al., 2022).

The validation results show that the LKPD developed meets all indicators in the "highly valid" category. Validation by media experts covers three main indicators, namely devices, visual communication, and media characteristics. The average score obtained from these three indicators is 0.9086, which falls into the highly valid category. The device aspect scored 0.8438, indicating that the LKPD structure was systematically arranged and in accordance with the applicable learning device format. Visual communication scored 0.9444, reflecting that the LKPD display was attractive, informative, and able to support students' understanding of the material presented. The media characteristics scored 0.9375, indicating that the LKPD has been adapted to the characteristics of fourth-grade elementary school students in terms of design, illustrations, and content presentation (Melindawati, 2021; Putra & Rezania, 2023).

Validation by language experts aims to assess the linguistic aspects of the LKPD, which include clarity, language, appropriateness, and use of terminology. The average score

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obtained was 0.9401, with all aspects falling into the highly valid category. Clarity received a score of 0.9167, indicating that the sentences in the LKPD were clearly structured and not long-winded. Linguistic correctness scored 0.8438, reflecting that the sentence structure and spelling are in accordance with the rules of good and correct Indonesian. Appropriateness scored a perfect 1.0000, indicating that the language used is appropriate for the cognitive development level of the students. The use of terminology also received a score of 1.0000, indicating that the terms used were appropriate for the IPAS context and were used consistently. High linguistic validity ensures that the LKPD can be easily understood by students and supports an effective learning process (Pawestri & Zulfiati, 2020; Widiyanti & Nisa, 2021).

Validation by subject matter experts covers the curriculum, content, presentation, and feasibility. The average score obtained was 0.9063, which falls into the highly valid category. The curriculum aspect received the highest score of 0.9583, indicating that the LKPD has been developed in accordance with the IPAS learning outcomes in the Merdeka Curriculum. Implementation received a score of 0.9167, indicating that the LKPD can be implemented practically in the classroom. Presentation received a score of 0.8929, reflecting that the material is presented systematically and logically. Content received a score of 0.8571, indicating that the LKPD content covers relevant IPAS concepts and is compiled contextually.

These findings are in line with research (Kusumasari et al., 2025; Mahjatia et al., 2021; Tamara et al., 2022a) which states that project-based LKPD with a STEAM approach is considered very feasible for use by teachers and students because of its systematic, communicative design that is in line with the characteristics of the students. In addition, it also has a high validity score based on assessments of material, appearance, and language aspects. The worksheets are considered capable of increasing student engagement in learning and facilitating contextual understanding of concepts in accordance with research (Jayanti & Yunianta, 2022; Tamara et al., 2022b).

Additionally, a study by (Herlina et al., 2022) shows that the validity of STEAM-PjBL-based LKPD can be seen from the suitability of the content with project-based learning syntax and the integration of STEAM elements that support the development of science literacy. Research by (E. Lestari et al., 2022) also emphasizes the importance of media validity in supporting student visual engagement and instructional communication effectiveness. Another opinion from (Yuliana, 2023) adds that language validity in LKPD greatly determines the success of concept understanding, especially in abstract material. Another opinion from (Sari, 2023) states that the content validity of LKPD must reflect the connection between IPAS material and real life so that learning becomes meaningful. Similarly, (Martatiyana et al., 2024) emphasizes that the validity of LKPD must also include the aspect of feasibility so that the tools can be used flexibly in various learning models.

The use of Student Worksheets (LKPD) in Science and Social Studies (IPAS) learning based on the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach combined with the Project Based Learning (PjBL) model has shown significant

effectiveness in improving students' science literacy. This effectiveness is reflected in the increase in pretest and posttest scores obtained by students after participating in learning using the developed LKPD. The average pretest score of 53.00 increased to 81.00 on the posttest, with an average n-Gain value of 0.65. Based on the gain classification, this value falls into the moderate category, which indicates a significant increase in understanding of the IPAS material taught.

This increase in scores not only demonstrates success in cognitive aspects, but also reflects that STEAM-PjBL-based LKPD is able to encourage contextual understanding of IPAS concepts. Contextualizing learning allows students to relate scientific concepts to everyday phenomena, making learning more meaningful and relevant. In addition, this approach has also been proven to improve students' scientific thinking skills, such as the ability to observe, identify problems, formulate hypotheses, and develop data-based solutions.

Research conducted by (Sari, 2023; Yuliana, 2023) supports these findings, where the application of the STEM-PjBL model in IPAS learning for fourth-grade elementary school students was able to significantly improve creativity and science literacy. Student creativity is evident in their ability to design simple projects related to science and technology material, while science literacy improves through their ability to read, understand, and interpret scientific information. This shows that the integration of the STEAM approach and the PjBL model provides space for students to learn actively, exploratively, and reflectively.

Another study by (S. Lestari, 2021) also shows that the use of Project Based Learning-based LKPD integrated with the STEAM approach can improve the effectiveness of IPAS learning in elementary schools. In this study, students showed an increase in their ability to connect scientific concepts with everyday life. They became more active in the process of exploration, group discussions, and project presentations. These activities encouraged students to be fully involved in the learning process, so that learning was not only a transfer of knowledge, but also a transformation of understanding.

Research by (Melindawati, 2021) notes that STEAM-PjBL-based LKPD not only improves learning outcomes in cognitive aspects but also has a positive impact on students' affective and psychomotor aspects. The affective aspect is evident in the increase in students' learning motivation, curiosity, and scientific attitudes, while the psychomotor aspect is reflected in students' skills in conducting experiments, making products, and presenting their work. Thus, STEAM-PjBL-based LKPD contributes to the holistic development of students' competencies.

Yuliana (2023) found in her research that STEAM-based LKPD developed for human respiratory system material was able to significantly improve students' critical thinking and science literacy skills. The average n-Gain in the study reached 0.72, which is in the high category. This improvement shows that LKPD designed with the STEAM approach can stimulate students to think analytically, evaluate information, and construct arguments based on the data obtained. Critical thinking skills are one of the essential skills in 21st-century learning, making this approach highly relevant for application in IPAS learning.

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Meanwhile, Martatiyana et al., (2024) developed STEM-PjBL-based E-LKPD IPAS to improve the collaboration skills of elementary school students. The effectiveness results showed that n-Gain was 0.5 in observation and 0.4 in peer assessment, both of which were in the moderate category. Collaboration skills are an important part of students' social competencies, which include the ability to work together, communicate, and complete tasks as a team. By using project-based E-LKPD and the STEAM approach, students are trained to share ideas, discuss solutions, and develop products together, making learning more interactive and cooperative.

Research by Sari (2023) also supports the effectiveness of the STEAM-PjBL approach, in which the LKPD developed for force and motion material resulted in a significant increase in students' science literacy. This improvement was particularly evident in reasoning and problem-solving. Students were able to identify the forces acting on an object, analyze the motion that occurred, and formulate explanations based on simple physics principles. This ability demonstrates that the STEAM-PjBL approach can develop the higher-order thinking skills that are essential in science education.

The STEAM-PjBL approach in the development of IPAS worksheets is able to integrate critical thinking skills, scientific exploration, collaboration, and evidence-based problem solving. These skills are highly relevant to the demands of 21st-century learning, which emphasizes the development of higher-order thinking skills, communication skills, and technological literacy. Therefore, the use of STEAM-PjBL-based LKPD in IPAS learning is an appropriate strategy to improve the quality of learning and students' overall competencies.

Conclusion

Based on the research findings, the STEAM-PjBL-based IPAS LKPD developed in this study is proven to be valid, practical, and effective for elementary school learning. Expert validation confirms that the LKPD meets high standards in terms of media design, language clarity, and content relevance aligned with IPAS learning outcomes, STEAM-PjBL syntax, and science literacy indicators. Practicality results show that both teachers (86.1%) and students (86.6%) perceive the LKPD as very practical, easy to use, and engaging. Furthermore, its effectiveness is evidenced by a significant improvement in students' science literacy, with the average score increasing from 53.00 to 81.00 and an n-Gain of 0.65 (moderate category). This study contributes by providing an empirically validated STEAM-PjBL-based LKPD that integrates science literacy within the Merdeka Curriculum, offering a practical instructional resource for teachers and enriching learning experiences that support scientific thinking, problem-solving, and contextual understanding in elementary education.

Acknowledgments

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