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Development of Interactive Digital Student Worksheets for IPAS Learning on Plant Parts for Fourth Grade Elementary School Students

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Abstract: This study aims to develop and evaluate a digital Student Worksheet (LKPD) for IPAS learning on the topic of plant parts for fourth-grade elementary school students. The research employed a Research and Development (R&D) approach, which included the stages of needs analysis, design, development, and product testing. Expert validation was conducted by subject-matter experts, media experts, and language experts to assess the feasibility of the content, visual design, language use, and usability of the digital LKPD. Practicality testing was carried out through one-to-one evaluation and small group testing, while effectiveness was analyzed by comparing pretest and posttest scores and calculating students' N-gain values. The results indicate that the digital LKPD demonstrates a high level of validity and practicality, with the content, media, and language aspects categorized as very valid, and good ease of use and acceptability observed in the practicality tests. Analysis of learning outcomes shows an increase in students' average scores from pretest to posttest, with the average N-gain falling into the high category, indicating that the digital LKPD supports students' conceptual understanding of plant parts. This study concludes that the use of digital LKPD can serve as an alternative interactive learning medium that promotes active student engagement; however, further testing on other subject matter and with larger samples is needed to strengthen these findings.

Keywords: Active learning; Constructivist approach; Digital LKPD; Elementary school; IPAS; Learning effectiveness

Introduction

The development of digital technology has brought significant changes to the field of education, particularly in the provision of learning resources and instructional media. Studies indicate that the integration of digital technology into learning has transformed traditional interactions between teachers and students and expanded the variety of available learning media, thereby making the learning process more innovative and contextual (Kalbergenova et al., 2026; Haleem et al., 2022; Zou et al., 2025). In the current digital era, the systematic use of digital learning media can enhance students' motivation, interactivity, and access to more dynamic learning materials compared to conventional media (Huang et al., 2019). Moreover, technological advancement is viewed as a key pillar in supporting adaptive and student-centered learning, rather than merely serving as an additional instructional tool (Yaseen et al., 2025). In line with the shift in learning paradigms in the digital era, student-centered learning approaches have been proven to increase student engagement and conceptual understanding compared to traditional, passive lecture-based methods. Research shows that the implementation of active learning strategies can enhance student engagement, learning

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motivation, and higher-order thinking skills through activities that encourage active participation, including collaboration and reflection during the learning process in elementary schools (Sun et al., 2022). In the context of Natural and Social Sciences (IPAS) learning, the use of digital learning media not only supports conceptual reinforcement but also stimulates students' motivation and engagement, enabling complex materials to be accessed in more interactive and meaningful ways (Mebert et al., 2020). Other studies report that digital media, particularly in elementary science learning, can significantly improve students' motivation and engagement (Oktania et al., 2025). Further research emphasizes that interactively designed digital media can increase students' active participation and responsiveness to IPAS learning materials, as well as help students relate learning concepts to real-life experiences (Daryanes et al., 2023). Therefore, instructional tools that facilitate meaningful, interactive learning activities and are aligned with the cognitive development stages of elementary school students are essential for improving the quality of IPAS learning.

One instructional tool that plays a crucial role in supporting active learning is the Student Worksheet (LKPD). LKPD functions as a guide for learning activities that assists students in understanding subject matter through structured tasks, observation, discussion, and reflection. Studies have shown that the use of LKPD contributes to learning effectiveness in elementary schools (Robiansyah et al., 2025). However, in practice, LKPD used in elementary schools is still predominantly print-based, often monotonous and lacking variation, whereas interactive models based on platforms such as Liveworksheets have been shown to increase student engagement and learning motivation (Andani et al., 2025). This indicates that traditional instructional tools have not fully accommodated the learning needs of students in the digital era, potentially leading to low student engagement in the learning process. The need to develop more interactive and contextual LKPD is further reinforced by studies on technology-based LKPD development that enhances students' overall learning experiences (Rahmayani & Atmazaki, 2025).

To address these challenges, the development of digital LKPD emerges as a relevant alternative. Digital LKPD allows the integration of various multimedia elements, such as images, videos, animations, and interactive links, which can increase students' learning interest and conceptual understanding (El Hammoumi et al., 2022; Ruf et al., 2023). In addition, digital LKPD offers flexibility in use, both online and offline, and supports more independent learning, making the learning experience more personalized and responsive to students' needs (Putri & Raharjo, 2024). With these characteristics, digital LKPD is considered aligned with the needs of IPAS learning, which emphasizes exploration and the connection of concepts to students' daily lives.

The topic of plant parts is a fundamental component of IPAS learning in elementary schools and is closely related to students' surrounding environments. This topic requires an understanding of concepts related to the structure and function of plant parts, which ideally should be learned through observation and hands-on activities (Azevedo et al., 2022). However, based on field conditions, instruction on plant parts is often still delivered conventionally through verbal explanations and textbooks, resulting in passive student participation and difficulties in achieving deep conceptual understanding (Sofroniou et al., 2025). Other studies indicate that the development of digital LKPD based on problem-solving and contextual activities can enhance student engagement and understanding of science concepts compared to traditional instructional methods (Melesse et al., 2025).

Although numerous studies have demonstrated the effectiveness of digital LKPD in increasing student engagement and learning activity, initial observations and needs analysis conducted at SD Negeri 1 Terusan, Musi Banyuasin Regency, reveal that IPAS learning is still dominated by conventional approaches, with suboptimal use of media and LKPD. The LKPD commonly used is print-based and primarily functions as a learning guide, thus not fully engaging students in scientific activities. Limited facilities and the underutilization of technological devices have constrained the variety of learning activities, leading to low student participation, particularly in the topic of plant parts, which requires direct observation and contextual understanding. These conditions indicate a gap between the demands of IPAS learning, which emphasizes meaningful activities, and the instructional tools used in practice, highlighting the need for the development of more interactive digital LKPD that aligns with students' characteristics.

To ensure that the developed digital LKPD is truly suitable for use in learning, a well-planned development process and comprehensive feasibility evaluation are required. Feasibility testing is a critical stage to assess the appropriateness of digital LKPD in terms of content, visual design, language, and usability in learning. Thus, the development of digital LKPD not only produces an innovative product but also one that is valid, practical, and aligned with the needs of IPAS learning in elementary schools. Based on the above rationale, this study aims to develop and examine the feasibility of digital LKPD for IPAS learning on the topic of plant parts in elementary schools, grounded in needs analysis and actual classroom conditions. This study is expected

to contribute to the provision of high-quality digital learning tools and to serve as a reference for teachers in developing more effective and meaningful IPAS instruction.

Method

Research Type and Design

This study employed a Research and Development (R&D) method aimed at developing a digital Student Worksheet (LKPD) for the subject of Natural and Social Sciences (IPAS) on the topic of plant parts for fourth-grade elementary school students. The development process followed the ADDIE model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was selected due to its systematic and flexible nature, making it suitable for the development of technology-based instructional materials that are aligned with learner needs.

Research Site and Participants

The study was conducted at SD Negeri 1 Terusan, Musi Banyuasin Regency. The participants consisted of fourth-grade elementary school students as users of the digital LKPD and a fourth-grade teacher as an informant in the needs analysis and practicality testing stages. The selection of participants was based on their relevance to the characteristics of the study, particularly in relation to IPAS instruction and the utilization of learning media in elementary education.

Development Procedure

The development of the digital LKPD followed the stages of the ADDIE model as described below.

Analysis

This stage aimed to identify learning needs and instructional problems in IPAS learning. Data were collected through classroom observations, student needs questionnaires, and teacher needs questionnaires to obtain information regarding learning conditions, existing LKPD usage, technological readiness, and challenges encountered in the learning process.

Design

At this stage, the digital LKPD was designed by determining core competencies, formulating learning objectives, selecting plant parts content, designing problem-based learning activities, and developing the visual layout and interaction flow of the digital LKPD.

Development

The development stage focused on transforming the design into a complete digital LKPD product. The product was then validated by subject-matter experts and media experts to evaluate its feasibility in terms of content accuracy, language clarity, visual design, and usability.

Implementation

The revised digital LKPD, based on expert feedback, was implemented on a limited scale with fourth-grade students. This stage aimed to examine the practicality of the digital LKPD when used in IPAS learning activities.

Evaluation

Evaluation was conducted formatively at each stage of the development process to ensure product quality. A final evaluation was carried out to determine the feasibility and practicality of the digital LKPD based on expert validation results and user responses.

Data Collection Techniques

The data collection techniques used in this study are presented in Table 1.

Table 1. Data Collection Techniques

Technique	Function
Observation	To obtain data on classroom learning conditions and the use of learning media.
Questionnaires	To identify the needs of students and teachers and to assess the practicality of the digital LKPD.
Validation Sheets	To obtain expert judgments on the feasibility of the digital LKPD from subject-matter and media experts.
Test Instruments	To measure students' learning outcomes before and after using the digital LKPD.

Data Analysis Techniques

This study employed descriptive quantitative and qualitative data analysis techniques to evaluate the feasibility and practicality of the developed digital LKPD.

Quantitative Data Analysis

Quantitative data were obtained from expert validation results and response questionnaires completed by teachers and students. Each item in the questionnaire was rated using a five-point Likert scale. The collected data were analyzed using a percentage formula to determine the level of validity and practicality of the digital LKPD.

$$\text{Percentage} = \frac{\sum \text{Obtained Score}}{\sum \text{Obtained Score}} \times 100\% \quad (1)$$

The resulting percentage scores were then converted into feasibility and practicality categories using the criteria presented in Table 2.

Table 2. Interpretation of assessment results

Percentage (%)	Category
81–100	Very Practical
61–80	Practical
41–60	Fairly Practical
21–40	Less Practical
0–20	Not Practical

The digital LKPD was considered feasible and practical if it achieved a minimum percentage score within the feasible.

Qualitative Data Analysis

Qualitative data were obtained from suggestions, criticisms, and comments provided by subject-matter experts, media experts, teachers, and students. The qualitative data were analyzed through the following steps: Categorizing feedback based on assessment aspects (content, language, visual design, and usability), Drawing conclusions from the main findings, and using the analysis results as the basis for revising and improving the digital LKPD. This qualitative analysis aimed to ensure that the developed digital LKPD not only met quantitative feasibility criteria but also aligned with instructional needs and real classroom conditions.

Analysis of Students' Learning Outcomes

The analysis of learning outcomes was conducted to determine the effectiveness of the digital LKPD in enhancing students' understanding of the plant parts topic. The analysis consisted of three stages: analysis of pretest scores, analysis of posttest scores, and analysis of learning gains using the N-gain method.

Pretest Score Analysis

Pretest scores were analyzed to determine students' initial abilities before using the digital LKPD. The scores were calculated using the following formula:

$$\text{Percentage} = \frac{\sum \text{Obtained Score}}{\sum \text{Obtained Score}} \times 100\% \quad (2)$$

Posttest Score Analysis

Posttest scores were used to determine students' learning outcomes after using the digital LKPD. The calculation of posttest scores employed the same formula as that used for the pretest:

$$\text{Percentage} = \frac{\sum \text{Obtained Score}}{\sum \text{Obtained Score}} \times 100\% \quad (3)$$

Analysis of Learning Gain (N-Gain)

The improvement in students' learning outcomes was analyzed using the Normalized Gain (N-Gain). This analysis was conducted to measure the extent to which students' understanding increased after using the digital LKPD. The N-Gain value was calculated using the following formula:

$$N_{Gain} = \frac{\text{Posttest Score-Pretest Score}}{\text{Maximum Score-Pretest Score}} \quad (4)$$

The resulting N-Gain values were then interpreted to determine the level of improvement in students' learning outcomes, ranging from low to high improvement categories. This analysis provides an indication of the effectiveness of the digital LKPD in supporting students' conceptual understanding of the plant parts topic.

Table 3. N_{Gain} Score

Score	Category
$g \geq 0.70$	High
$0.30 \leq g < 0.70$	Mid
$g < 0.30$	Low

Result and Discussion

The following section presents the results of the development of the digital Student Worksheet (LKPD) designed to support Natural and Social Sciences (IPAS) learning on the topic of plant parts for fourth-grade elementary school students. The developed digital LKPD product is the result of the needs analysis, design, and development stages, which were aligned with students' characteristics and actual classroom conditions. The presentation of this product aims to provide an initial overview of the layout, structure, and main features of the digital LKPD before proceeding to the discussion of feasibility, practicality, and effectiveness testing results in the learning process. The appearance of the developed digital LKPD product is shown in the Figure 1, 2, and 3.

Figure 1. Cover interface

Based on the presented product display, the developed digital Student Worksheet (LKPD) contains systematically designed learning components, including material presentation, student activities, and interactive

learning support features. The product was designed to facilitate students' active engagement in understanding the topic of plant parts through contextual and structured learning activities. To ensure alignment with instructional standards, the next stage involved expert validation conducted by subject-matter experts, media experts, and language experts to assess the feasibility of the digital LKPD in terms of content, visual design, language, and usability prior to classroom implementation.

Figure 2. Material interface

Figure 3. Task interface

Expert Validation

Expert validation was conducted by three experts, namely a media expert, a language expert, and a subject-matter expert. This validation aimed to evaluate the suitability of the digital LKPD in terms of media design and usability, language clarity and accuracy, as well as the relevance and depth of the learning content. The validation results served as the basis for determining the feasibility level of the product and as a reference for revising and improving the developed digital LKPD. The results of the expert validation are presented in Table 4.

Based on the results presented in Table 4, the developed digital LKPD achieved a very high level of validity from all experts involved. The media expert assessment yielded a validity percentage of 82.6%, categorized as very valid, indicating that the layout, visual design, and media functionality met the criteria for a feasible digital learning tool. Validation by the subject-matter expert resulted in the highest percentage at 93%, categorized as very valid, demonstrating that the plant parts content was aligned with learning objectives, students' characteristics, and conceptual accuracy. Meanwhile, the language expert validation produced a percentage of 85%, also categorized as very valid, indicating that the language used in the digital LKPD was clear, communicative, and appropriate for the linguistic development level of elementary school students. Overall, the average validity score of 86.87% placed the digital LKPD in the very valid category, indicating that the product was suitable for implementation in the trial stage with only minor revisions based on expert suggestions. After the digital LKPD was declared very valid based on expert validation, the next stage involved conducting a practicality test to determine the ease of use and acceptability of the product in the learning process.

Table 4. Summary of expert validation results

Validation Expert	Validity Percentage (%)	Category
Media Expert	82.60	Very Valid
Subject Expert	93.00	Very Valid
Language Expert	85.00	Very Valid
Average	86.87	Very Valid

Practicality Testing

Practicality testing was conducted based on students' responses after using the digital LKPD in IPAS learning activities on the topic of plant parts. This process was carried out in two stages: a one-to-one evaluation and a small group test. The purpose of this test was to assess the extent to which the digital LKPD was easy to use, engaging, and supportive of the learning process, as well as to determine the readiness of the product for wider implementation. The results of the practicality testing are presented in Table 5.

Table 5. Summary of practicality test results

Practicality Stage	Percentage (%)	Category
One-to-One Test	76.80	Fairly Practical
Small Group Test	91.20	Very Practical
Average	84.00	Very Practical

Based on the results shown in Table 5, an improvement in the level of practicality was observed at each testing stage. In the one-to-one evaluation stage, the digital LKPD obtained an average percentage score of 76.80%, categorized as fairly practical. The language

aspect achieved the highest score and was categorized as very practical, indicating that the instructions and language used in the digital LKPD were easily understood by students. However, the content, visual design, and usefulness aspects were still categorized as fairly practical, suggesting that while the product was usable, improvements were needed, particularly in activity variation and visual optimization. In the small group test stage, the digital LKPD showed a significant improvement, with an average percentage score of 91.20%, categorized as very practical. All assessed aspects—including content, visual design, language, and usefulness—achieved the very practical category. These results indicate that revisions made based on feedback from the one-to-one evaluation positively impacted the ease of use, attractiveness, and instructional benefits of the digital LKPD in IPAS learning. Overall, these findings suggest that the developed digital LKPD has a high level of practicality and is suitable for implementation with a larger number of students. After the digital LKPD was confirmed to be very valid and practical, the next stage involved analyzing students' learning outcomes to determine the effectiveness of the digital LKPD in supporting learning.

Field Testing

Learning outcome analysis was conducted through the administration of pretests and posttests to students before and after the use of the digital LKPD on the topic of plant parts. The pretest and posttest results were used to examine improvements in students' conceptual understanding as an effect of the developed digital LKPD. The results of the pretest and posttest analysis are presented in Table 6.

Based on the data in Table 6, the pretest and posttest results indicate an improvement in students' learning outcomes after learning with the digital LKPD on the topic of plant parts. The average pretest score of 23.30 indicates that students' initial abilities were relatively low prior to the use of the digital LKPD. After participating in learning activities using the digital LKPD, the average posttest score increased significantly to 89.3, demonstrating a substantial improvement in students' conceptual understanding. The range of pretest scores (0–60) reflects variation in students' initial abilities, with most students not yet mastering the material. In contrast, posttest results show a minimum score of 80 and a maximum score of 100, indicating that nearly all students achieved high learning outcomes after using the digital LKPD. Overall, the comparison of pretest and posttest results demonstrates that the use of the digital LKPD had a positive impact on students' learning outcomes, particularly in improving conceptual understanding of plant parts in IPAS learning. In addition to comparing pretest and posttest scores, the effectiveness of the digital LKPD was further analyzed using the N-gain value to determine the proportional improvement in students' learning outcomes.

Table 6. Comparison of pretest and posttest results

Name	Pretest	Posttest	N-gain	Category
B	10	90	0.88	High
A Z	0	90	0.90	High
A	10	80	0.77	High
ASP	20	90	0.87	High
AK	30	80	0.71	High
DM	0	80	0.80	High
EA	0	80	0.80	High
HA	10	80	0.77	High
HAS	20	80	0.75	High
JHR	30	90	0.85	High
KF	20	100	1.00	High
K	40	90	0.80	High
KW	20	80	0.75	High
MF	0	90	0.90	High
M	20	80	0.75	High
NTA	40	90	0.83	High
N	50	90	0.80	High
NPF	50	90	0.80	High
PIP	50	90	0.80	High
RA	50	90	0.80	High
RA	50	80	0.60	High
RS	50	90	0.80	High
RS	50	80	0.60	Low
YS	50	90	0.80	High
ZZ	100	100	1.00	High
A	40	100	1.00	High
D	30	100	1.00	High
K	10	100	1.00	High
A	20	100	1.00	High
G	10	100	1.00	High
KA	20	100	1.00	High
A	10	90	0.80	High
AR	60	90	0.75	High
Amount	970	2870		
Average	23.30	89.30	0.84	High
Minimum	0	80		
Maximum	60	100		

(Source: Primary Data Processing, 2025)

Table 7. N-Gain calculation results

Average Pretest	Average Posttest	N-Gain	Category
23.39%	89.30%	0.84	High

Based on the N-gain calculation, an average N-gain value of 0.84 was obtained, which falls into the high category. This result indicates that the increase in students' learning outcomes—from an average pretest score of 23.30% to an average posttest score of 89.3% occurred significantly after the use of the digital LKPD. These findings demonstrate that the developed digital LKPD is effective in enhancing students' conceptual

understanding of the plant parts topic in elementary school IPAS learning.

Discussion

The results of this study indicate that the digital Student Worksheet (LKPD) developed for IPAS learning on the topic of plant parts in fourth-grade elementary school demonstrates a high level of validity and practicality, indicating its suitability as a supporting learning medium. Expert validation revealed that the content, media, and language aspects of the digital LKPD were all categorized as very valid (Widiyono et al., 2025). The high content validity suggests that the material aligns well with learning objectives, students' characteristics, and the scientific accuracy of plant part concepts (Pany et al., 2024). This finding is consistent with international studies showing that well-adapted and validated digital learning media for primary education can produce pedagogically sound and systematically structured products (Hanif & Maruti, 2025). Instructional design principles emphasize the importance of alignment among learning objectives, content, and learner characteristics to achieve meaningful learning experiences (Wijngaards-de Meij & Merx, 2018; Zhao et al., 2023). High validity in media and language aspects also indicates that the visual design, navigation, and language use adhere to principles of clarity, readability, and ease of use (Batool & Hussain, 2025; Tetzlaff et al., 2025).

The practicality test results obtained through one-to-one evaluation and small group testing show an improvement from the fairly practical category to the very practical category. This finding indicates that the digital LKPD became easier to use, more engaging, and more beneficial after revisions based on initial user feedback (Yani et al., 2024; León-López et al., 2021). From a theoretical perspective, the practicality of digital instructional tools is closely related to usability, which includes ease of navigation, readability, and efficient interaction between users and media (Batool & Hussain, 2025). These findings suggest that improvements in the visual design and instructional clarity of the digital LKPD can enhance students' learning experiences and support the teacher's role as a learning facilitator (Putri et al., 2025; Sari, 2024). Analysis of students' learning outcomes revealed a substantial increase in the average score from a pretest mean of 23.30 to a posttest mean of 89.30, with an average N-gain of 0.84 (high category). This result indicates that the digital LKPD effectively supports students' conceptual understanding of plant parts (Adnyanawati & Abadi, 2021). This finding is in line with previous studies reporting that the use of e-student worksheets or interactive digital media leads to higher learning outcomes compared to conventional instructional methods (Akbar, 2025; Santilli et al., 2025).

From a theoretical standpoint, the effectiveness of the digital LKPD can be explained through active and constructivist learning approaches, in which knowledge is constructed through students' active engagement in learning processes, including observing, questioning, experimenting, and reflecting (Srichinda et al., 2026; Saifi et al., 2024). This approach aligns with the view that science learning in elementary schools becomes more meaningful when students are actively involved in exploration and problem-solving activities that are relevant to their everyday experiences (Molnár & Greiff, 2023). Despite the promising findings, this study has several limitations, including the relatively small sample size limited to one fourth-grade class, the short duration of the implementation, and the focus on a single topic, namely plant parts (Sankalaite et al., 2025). Therefore, future research is recommended to examine the implementation of digital LKPD across different topics, involve larger and more diverse samples, and investigate its impact on higher-order thinking skills and science process skills (Al-Kamzari & Alias, 2025). Such studies would provide a more comprehensive understanding of the effectiveness of digital LKPD across various learning contexts. Overall, the findings of this study indicate that the developed digital LKPD has strong potential to enhance the quality of IPAS learning, both in terms of learning processes and learning outcomes. Nevertheless, further empirical testing is required to confirm its effectiveness on a broader scale and across diverse instructional settings (Abad & Hattie, 2025; Rahmi & Rassanjani, 2025).

Conclusion

Based on the results of the study, it can be concluded that the digital Student Worksheet (LKPD) developed for IPAS learning on the topic of plant parts in fourth-grade elementary school demonstrates a very high level of validity and practicality, and is therefore feasible to be used as a supporting learning medium. Expert validation results indicate that the material, media, and language aspects of the digital LKPD fall into the very valid category, reflecting the alignment of content with learning objectives, student characteristics, and appropriate instructional media standards. In addition, practicality testing shows that the digital LKPD is easy to use, well accepted, and attractive to students. In terms of effectiveness, the analysis of students' learning outcomes reveals a significant improvement from pretest to posttest scores, with the average N-gain categorized as high. These findings suggest that the digital LKPD effectively supports students' conceptual understanding of plant parts through more interactive and contextual learning activities. This result is consistent with the principles of

active and constructivist learning, which emphasize students' active engagement in constructing knowledge through meaningful learning experiences. Nevertheless, this study has several limitations, including a limited sample size, a relatively short implementation period, and a narrow focus on learning content. Therefore, future research is recommended to implement the digital LKPD across different IPAS topics, involve larger and more diverse samples, and examine its impact on higher-order thinking skills and science process skills. Such efforts are expected to provide a more comprehensive understanding of the effectiveness of digital learning media in elementary school IPAS instruction.

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Conceptualization, methodology, data curation, writing—review and editing, N.N.S., S.S., and C.H.; validation, supervision, S.S. and C.H.; formal analysis, investigation, resources, writing—original draft preparation, N.N.S.

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The authors declare no conflict of interest.

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