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DEVELOPMENT OF 4D MODEL–BASED STUDENT WORKSHEETS TO IMPROVE LEARNING INDEPENDENCE IN GRADE V ELEMENTARY SCHOOL

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Abstract

This study aimed to develop Student Worksheets (LKPD) based on the 4D model (Define, Design, Develop, and Disseminate) in science learning to improve the learning independence of fifth-grade elementary school students. The research employed a Research and Development (R&D) approach using the 4D development model. The study was conducted in elementary schools within the General Sudirman Cluster, Taman District, Pemalang Regency. Data were collected through expert validation, learning independence questionnaires, and pretest–posttest instruments. The feasibility of the developed LKPD was evaluated based on validity, practicality, and effectiveness criteria. The results of expert validation indicated that the LKPD was categorized as valid and suitable for use. Statistical analysis showed an improvement in students' learning independence after the implementation of the 4D model–based LKPD in the experimental class compared to the control class. These findings indicate that the developed LKPD is feasible, practical, and effective as an alternative instructional material to support student-centered science learning and enhance

learning independence among fifth-grade elementary school students.
Keywords: Student worksheets, 4D model, learning independence

Abstrak

Penelitian ini bertujuan untuk mengembangkan Lembar Kerja Siswa (LKPD) berdasarkan model 4D (Definisi, Desain, Pengembangan, dan Penyebaran) dalam pembelajaran sains untuk meningkatkan kemandirian belajar siswa kelas lima sekolah dasar. Penelitian ini menggunakan pendekatan Penelitian dan Pengembangan (R&D) dengan menggunakan model pengembangan 4D. Penelitian ini dilakukan di sekolah dasar di Klaster Jenderal Sudirman, Kecamatan Taman, Kabupaten Pemalang. Pengumpulan data dilakukan melalui validasi ahli, kuesioner kemandirian belajar, dan instrumen pretest-posttest. Kelayakan LKPD yang dikembangkan dievaluasi berdasarkan kriteria validitas, kepraktisan, dan efektivitas. Hasil validasi ahli menunjukkan bahwa LKPD dikategorikan sebagai valid dan layak digunakan. Analisis statistik menunjukkan peningkatan kemandirian belajar siswa setelah penerapan LKPD berbasis model 4D di kelas eksperimen dibandingkan dengan kelas kontrol. Temuan ini menunjukkan bahwa LKPD yang dikembangkan layak, praktis, dan efektif sebagai bahan pembelajaran alternatif untuk mendukung pembelajaran sains yang berpusat pada siswa dan meningkatkan kemandirian belajar di kalangan siswa kelas lima sekolah dasar.

Kata kunci: Lembar kerja siswa, model 4D, kemandirian belajar

INTRODUCTION

Learning independence is one of the key competencies required in 21st-century education, as it reflects students' ability to manage, regulate, and evaluate their own learning processes. Independent learners tend to demonstrate higher initiative, responsibility, and persistence in completing learning tasks. In the context of elementary education, learning independence is particularly important because it serves as a foundation for students' academic development at higher levels of education.

However, empirical conditions in elementary schools indicate that students' learning independence, especially in Grade V, has not yet developed optimally. Based on preliminary observations conducted in several elementary schools within the General Sudirman Cluster, Taman District, Pemalang Regency, many students still show a high dependency on teachers during the learning process. Students often wait for detailed instructions, show limited initiative in completing tasks, and tend to rely on peers' answers rather than engaging actively with learning materials. This condition suggests that students' independent learning skills require systematic support through appropriate learning tools and strategies.

One of the learning tools that can support the development of learning independence is the Student Worksheet (Lembar Kerja Peserta Didik/LKPD). LKPD serves not only as a learning guide but also as a medium that encourages students to explore concepts, practice problem-solving, and reflect on their learning outcomes independently. Well-designed LKPD can shift learning from

teacher-centered to student-centered, enabling students to become more active and responsible for their own learning.

The development of LKPD requires a systematic and structured approach to ensure its validity, practicality, and effectiveness. One development model that is widely used in educational research is the 4D model, consisting of Define, Design, Develop, and Disseminate stages. The 4D model provides a clear framework for identifying learning needs, designing learning products, validating and revising products through expert judgment and trials, and disseminating effective learning tools. Previous studies have shown that learning materials developed using the 4D model have the potential to improve learning outcomes and student engagement.

Despite the growing number of studies on LKPD development, research focusing specifically on LKPD designed to enhance learning independence in elementary science learning remains limited, particularly in the context of the Independent Curriculum (Kurikulum Merdeka). Therefore, this study seeks to address this gap by developing 4D model–based Student Worksheets for science learning aimed at improving the learning independence of fifth-grade elementary school students.

Accordingly, the objectives of this study are: (1) to describe the process of developing Student Worksheets (LKPD) based on the 4D model in science learning, (2) to determine the feasibility of the developed LKPD in terms of validity, practicality, and effectiveness, and (3) to analyze the improvement of learning independence among fifth-grade elementary school students after using the developed LKPD.

METHODS

This study employed a Research and Development (R&D) approach using the 4D development model, which consists of four stages: Define, Design, Develop, and Disseminate**.** The 4D model was selected because it provides a systematic framework for developing learning tools that are valid, practical, and effective.

Research Setting

The research was conducted in Assisted Area IV (Dabin IV), Taman District, Pemalang Regency. This area consists of two clusters of elementary schools, namely the General Sudirman Cluster and the Diponegoro Cluster, which actively participate in Teacher Working Group (KKG) activities and the implementation of the Independent Curriculum. These schools were selected because they represent diverse student characteristics and learning conditions, making them suitable for testing the developed learning product.

Research Subjects

The population of this study consisted of fifth-grade elementary school students in Dabin IV, Taman District, Pemalang Regency. The total population was 100 students**.** The sampling technique used was purposive sampling**,** based on considerations relevant to the research objectives.

Using the Slovin formula with a margin of error of 5%, a sample of 50 students was obtained. The sample was divided into two groups: 25 students in the experimental class and 25 students in the control class.

Development Procedure

The development process followed the stages of the 4D model:

1. Define, which involved analyzing curriculum requirements, student characteristics, and learning needs related to science learning and learning independence.
2. Design, which focused on designing the initial prototype of the Student Worksheets (LKPD), including learning objectives, activities, and assessment components.
3. Develop, which included expert validation (material experts, language experts, and media experts), limited trials, and revisions based on feedback to improve the quality of the LKPD.
4. Disseminate, which involved implementing the finalized LKPD in classroom learning and distributing it to selected schools as a learning resource.

Data Collection Techniques

Data were collected using several instruments, including 1) Validation sheets, to assess the validity of the LKPD from material, language, and media experts. 2) Learning independence questionnaires, to measure students' learning independence before and after using the LKPD. 3) Pretest and posttest instruments, to support the analysis of learning outcomes in the experimental and control classes.

Data Analysis

The collected data were analyzed quantitatively. Validation data were analyzed using percentage scores to determine the level of feasibility of the developed LKPD. The results of the learning independence questionnaire and pretest–posttest data were analyzed using SPSS to examine differences between the experimental and control classes. The analysis results were used to determine the effectiveness of the 4D model–based LKPD in improving students' learning independence.

RESULTS AND DISCUSSION

Results

This study involved 50 fifth-grade elementary school students, consisting of 25 students in the experimental class and 25 students in the control class. Prior to the implementation of the 4D model–based Student Worksheets (LKPD), both groups were administered a pretest to measure students' initial learning conditions and ensure equivalence between groups. The pretest consisted of 10 multiple-choice questions, which were developed based on learning objectives and indicators of science learning.

The results of the pretest instrument validity analysis using SPSS showed that all items were valid. With a total sample size of 50 students and a significance level of $\alpha = 0.05$, the r-table value was 0.273. All item correlation coefficients exceeded this value, indicating that each item was capable of measuring the intended construct. Furthermore, the reliability test produced a

coefficient of 0.891**,** which is categorized as very strong reliability**,** suggesting that the instrument was consistent and reliable for assessing students' learning outcomes.

After the learning intervention, a posttest was administered to both the experimental and control classes using a similarly structured instrument. The results of the posttest validity analysis indicated that all test items were valid, with correlation values exceeding the r-table threshold. The posttest reliability coefficient was 0.768**,** which also falls into the very strong category**,** confirming the consistency of the instrument in measuring students' learning outcomes after treatment.

Descriptive statistical analysis revealed differences in learning outcomes between the experimental and control classes. The average pretest score of the experimental class was 85.6, while the control class obtained an average score of 61.5**.** After the implementation of the learning process using the 4D model–based LKPD, the average posttest score of the experimental class increased to 86.7, whereas the control class achieved an average score of 63.4**.** Although the numerical increase in scores appears modest, the experimental class consistently demonstrated better performance than the control class, indicating the positive influence of the developed LKPD on students' learning processes.

In addition to cognitive learning outcomes, the feasibility of the developed LKPD was evaluated through expert validation**,** involving material experts, language experts, and media experts. The **l**anguage expert assessment resulted in a feasibility percentage of 86%**,** categorized as good**,** indicating that the language used in the LKPD was clear, appropriate for students' developmental levels, and communicative. The material expert assessment also yielded a feasibility percentage of 86%**,** demonstrating that the content was accurate, aligned with learning objectives, and relevant to students' daily experiences. Meanwhile, the media expert assessment showed a feasibility percentage of 86%**,** categorized as good, indicating that the visual design, layout, typography, and illustrations were appropriate and supportive of learning activities. These results confirm that the developed LKPD meets the criteria of validity, practicality, and effectiveness, making it suitable for use in elementary school science learning.

Discussion

The findings of this study indicate that the implementation of Student Worksheets (LKPD) developed using the 4D model has a positive effect on improving students' learning independence in science learning. The higher posttest scores achieved by the experimental class compared to the control class suggest that students who used the developed LKPD were more actively involved in the learning process and better able to engage with learning materials independently.

The effectiveness of the developed LKPD can be attributed to the systematic stages of the 4D model**.** During the Define stage**,** an analysis of curriculum requirements, student characteristics, and learning needs was conducted. This stage ensured that the LKPD addressed real classroom problems, particularly the low level of student learning independence observed during preliminary studies. By aligning learning materials with students' needs, the LKPD provided relevant and meaningful learning experiences.

At the Design stage, the LKPD was structured to include clear learning objectives, guided inquiry activities, and reflective questions. These components encouraged students to actively explore concepts, make observations, and draw conclusions independently. This design supports the principles of student-centered learning, where students are not merely passive recipients of information but active participants in constructing knowledge.

The Develop stage played a crucial role in enhancing the quality of the LKPD through expert validation and revisions. Feedback from material, language, and media experts helped refine the content, improve clarity of instructions, and enhance visual presentation. This process ensured that the LKPD was not only theoretically sound but also practical and engaging for elementary school students. Well-designed learning materials can increase students' motivation and confidence, which are essential components of learning independence.

Furthermore, the Disseminate stage enabled the implementation of the finalized LKPD in real classroom settings. The use of the LKPD in the experimental class allowed students to practice independent learning behaviors, such as reading instructions carefully, completing tasks without excessive teacher guidance, and reflecting on their learning outcomes. These activities are closely related to the concept of self-regulated learning, which emphasizes students' ability to plan, monitor, and evaluate their own learning processes.

The findings of this study are consistent with previous research that highlights the effectiveness of the 4D model in developing learning tools that enhance student engagement and independence. Learning materials developed through structured and validated processes tend to foster learning environments that support autonomy and responsibility. In line with Zimmerman's self-regulated learning theory, the use of LKPD encourages students to take control of their learning activities, thereby strengthening their learning independence.

Moreover, the positive results of expert validation indicate that the developed LKPD fulfills the criteria of a high-quality learning resource. The combination of accurate content, clear language, and attractive design contributes to students' willingness to engage with learning materials independently. This finding reinforces the importance of integrating pedagogical, linguistic, and visual aspects in the development of learning tools.

Overall, the results and discussion demonstrate that the development of LKPD based on the 4D model is an effective approach to enhancing learning independence among fifth-grade elementary school students. The findings provide empirical evidence supporting the use of structured development models in creating learning tools that align with the goals of the Independent Curriculum, particularly in promoting active, independent, and student-centered learning.

Figure 1
Activities of students in the experimental class

Figure 2
Activities of students in the control class

Figure 1 illustrates the learning activities of students in the experimental class during the implementation of the instructional intervention. Based on the observation reflected in the figure, students in the experimental class demonstrate a high level of engagement throughout the learning process. The activities are characterized by active participation, collaborative interaction, and consistent involvement in learning tasks. Students appear to be more focused on the learning materials, actively responding to teacher instructions, and participating in discussions with peers. This condition indicates that the learning model applied in the experimental class successfully created an interactive and student-centered learning environment.

Furthermore, Figure 1 suggests that students in the experimental class were not merely passive recipients of information but were actively involved in constructing their understanding. Activities such as asking questions, sharing ideas, completing tasks independently or in groups, and responding to feedback occurred more frequently. This level of engagement reflects the effectiveness of the instructional strategy in stimulating students' motivation and encouraging meaningful learning. High student activity is often associated with better comprehension and retention of learning materials, as students are given opportunities to actively process information rather than relying solely on teacher explanations.

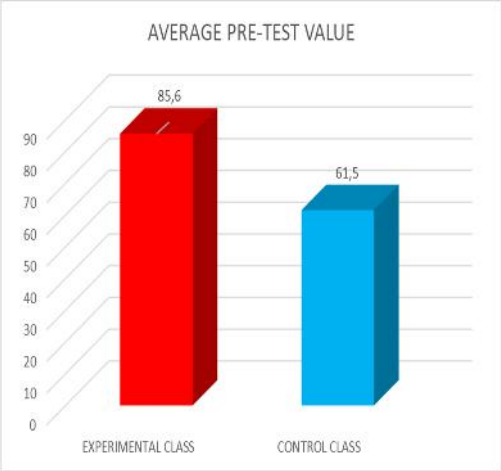
In contrast, Figure 2 presents the learning activities of students in the control class. Compared to the experimental class, the control class shows a relatively lower level of student activity. Learning activities in the control class tend to be more teacher-centered, with students spending more time listening to explanations rather than actively participating in the learning process. Although some students were involved in completing tasks or responding to questions, the overall level of interaction and engagement appears less intense than that observed in the experimental class.

The limited student activity in the control class may indicate that the instructional approach used did not fully encourage students to actively engage with the learning materials. Students were more likely to wait for instructions, follow examples provided by the teacher, and complete tasks individually without extensive discussion or collaboration. As a result, opportunities for students to develop higher-order thinking skills, communication skills, and independent learning habits were relatively limited.

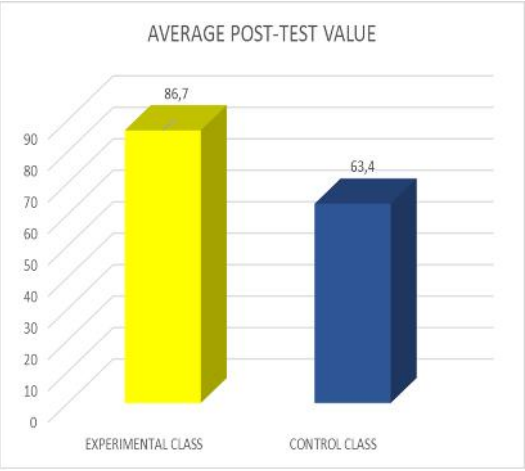
A comparative analysis of Figure 1 and Figure 2 highlights clear differences in student engagement between the two classes. The experimental class demonstrates a more dynamic learning atmosphere, where students are actively involved in various learning activities, while the control class reflects a more conventional learning pattern. These differences suggest that the instructional model implemented in the experimental class had a positive impact on students' learning behavior, particularly in fostering active participation and collaborative learning.

From an educational perspective, increased student activity, as shown in the experimental class, is a crucial indicator of effective learning. Active learning environments encourage students to take responsibility for their learning, develop problem-solving skills, and build deeper conceptual understanding. Therefore, the findings illustrated in these figures support the argument that innovative and well-structured instructional approaches are more effective in promoting active student engagement than traditional teaching methods.

In conclusion, Figure 1 and Figure 2 provide visual evidence of differences in student learning activities between the experimental and control classes. The experimental class exhibits higher levels of student activity, engagement, and interaction, while the control class shows more limited participation. These findings reinforce the importance of using student-centered learning models to enhance classroom activity and improve overall learning quality.



Graph 1. Average pre test value



Graph 2. Average post test value

The two graphs presented illustrate a comparative analysis of the average pre-test and post-test scores between the experimental class and the control class. These visual representations play a crucial role in demonstrating the initial equivalence of students' abilities prior to the intervention and the learning outcomes achieved after the instructional treatment was implemented. By

examining both graphs comprehensively, it is possible to understand not only the numerical differences between the two groups but also the educational implications of the applied learning model.

The first graph depicts the average pre-test values of the experimental class and the control class. Based on the graph, the experimental class obtained an average pre-test score of 85.6**,** while the control class recorded a lower average score of 61.5. This finding indicates that, prior to the learning intervention, students in the experimental class already demonstrated a relatively higher level of initial competence compared to those in the control class. The difference in pre-test scores suggests variability in students' prior knowledge or learning readiness, which is a common condition in real classroom settings. Although the experimental class showed a higher initial average, the pre-test results primarily function as a baseline measurement, allowing researchers to observe changes in learning outcomes after the instructional treatment is applied.

Despite the difference in initial scores, the pre-test graph does not yet reflect the effectiveness of the learning model or instructional strategy under investigation. Instead, it serves as an important reference point to evaluate learning progress. The pre-test results confirm that students entered the learning process with differing academic starting points, thereby reinforcing the importance of analyzing post-test outcomes and learning gains rather than relying solely on absolute scores. From a methodological perspective, the presence of pre-test data strengthens the validity of the study, as it allows for a more accurate interpretation of learning improvements following the intervention.

The second graph illustrates the average post-test values of both classes after the learning activities were completed. According to the graph, the experimental class achieved an average post-test score of 86.7**,** while the control class reached an average score of 63.4**.** When compared to the pre-test results, both classes show an increase in average scores, indicating that learning occurred in both instructional settings. However, the magnitude and consistency of improvement differ between the two groups.

In the experimental class, the increase from a pre-test average of 85.6 to a post-test average of 86.7 reflects a positive, albeit modest, improvement. This result suggests that the learning intervention implemented in the experimental class was effective in reinforcing students' understanding and maintaining high academic performance. The relatively stable increase may also indicate that students had already reached a high level of mastery prior to the intervention, leaving limited room for dramatic score improvement. Nevertheless, the post-test results demonstrate that the instructional approach applied in the experimental class was able to sustain and slightly enhance students' learning outcomes.

In contrast, the control class experienced an increase from an average pre-test score of 61.5 to a post-test score of 63.4. Although this improvement confirms that conventional instruction also contributed to learning progress, the increase is relatively small and remains substantially lower than that of the experimental class. This suggests that the instructional strategy used in the control class may have been less effective in facilitating significant conceptual understanding or skill development. The persistent gap between the experimental and control classes in both pre-test and

post-test scores highlights differences in learning effectiveness between the two instructional approaches.

When the two graphs are analyzed comparatively, a clearer pattern emerges. The experimental class consistently outperformed the control class in both pre-test and post-test assessments. More importantly, the post-test graph reinforces the argument that the learning model applied in the experimental class provided a more supportive and effective learning environment. The experimental class not only maintained its superior performance but also demonstrated learning stability and consolidation of knowledge. This outcome aligns with educational theories that emphasize the role of structured, student-centered, and well-designed instructional materials in promoting meaningful learning.

Furthermore, the graphical comparison underscores the importance of instructional quality in influencing learning outcomes. While both groups showed improvement, the experimental class achieved higher overall achievement levels, suggesting that the intervention contributed positively to students' learning experiences. The visual clarity of the graphs allows readers to easily identify performance trends, differences between groups, and the overall effectiveness of the instructional treatment. As such, these graphs function not merely as descriptive visuals but as analytical tools that support the study's research findings.

From an educational perspective, the results presented in the graphs imply that innovative or structured instructional approaches—such as the one implemented in the experimental class—can lead to better learning outcomes compared to conventional teaching methods. The higher post-test scores in the experimental class indicate improved comprehension, retention, and application of learning materials. This finding is particularly relevant for elementary education, where instructional strategies play a crucial role in shaping students' academic development and learning motivation.

In summary, the first graph establishes the baseline academic conditions of both classes through pre-test scores, while the second graph demonstrates the learning outcomes achieved after instruction. The experimental class consistently shows higher average scores than the control class, both before and after the intervention. The post-test results, in particular, provide strong evidence that the instructional approach applied in the experimental class was more effective in supporting student learning. Together, these graphs offer a coherent and compelling visual narrative that strengthens the study's conclusions regarding the effectiveness of the implemented learning model.

CONCLUSION

This study concludes that the Student Worksheets (LKPD) developed using the 4D model (Define, Design, Develop, and Disseminate) are feasible, practical, and effective for use in elementary science learning. The development process followed systematic stages, resulting in LKPD that align with the Independent Curriculum and support student-centered learning.

The results of expert validation involving material experts, language experts, and media experts indicate that the developed LKPD meets the criteria of validity and suitability for

classroom implementation. In addition, the implementation of the 4D model–based LKPD shows a positive impact on improving the learning independence of fifth-grade elementary school students, as evidenced by better learning outcomes in the experimental class compared to the control class.

Therefore, the developed LKPD can be used as an alternative instructional material to support science learning that promotes active participation, independence, and responsibility among students. This study also provides empirical evidence that the 4D development model is an effective framework for designing learning tools that enhance students' learning independence at the elementary school level.

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