JPPIPA 11(3) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of Experiment-Based IPAS Exploration Sheet (LEPAS) on the Material of the Effect of Force on Objects

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Received: December 27, 2024
Revised: February 11, 2025
Accepted: March 25, 2025
Published: March 31, 2025

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DOI: 10.29303/jppipa.v11i3.10211

Abstract: The learning process will be effective if supported by learning media that is right on target and based on student needs analysis. LEPAS (Student Exploration Sheet) as a learning media is characterized by integrated activities with traditional games as activities. In addition, LEPAS has the advantage that the activities carried out are able to foster student experimentation but use simple experimental materials so that they are easily implemented by students. Experimental science is a very suitable learning method to be applied in science learning. This research uses the RND method by developing LEPAS. The 4D RND model was chosen as the development model. The research subjects were fourth grade students of SD Al Islam Yogyakarta and their class teachers. The results showed that the LEPAS media that had been developed had received validation by experts with the results of the percentage of material validation of 95%, media 90.66%, language 88.33% with a very valid category. Based on the needs analysis, the results show that the developed media is very suitable for grade IV elementary school because this media accommodates the needs of students, especially in science learning which requires experiment-based activities. LEPAS is declared feasible to use as media in Class IV based on the analysis of student needs to accommodate experimental learning.

Keywords: Experiments; Learning media; LEPAS; Science

Introduction

One of the most important aspects of education is the curriculum. Hidayani (2018) reveals that the curriculum has a very important role in all forms of educational endeavors. The curriculum must be designed to improve quality standards to be effective in setting educational goals. The curriculum, as an important component of education, has a strategic position in education (Insani, 2019). The overall quality of education is greatly influenced by the existence of the curriculum.

In addition, the curriculum should consider the opinions of students, teachers, the general public, and teacher input. As the target audience of the curriculum, students should have the highest priority when developing the curriculum (Setiyorini et al., 2023). According to Agustina et al. (2022), this autonomous curriculum combines learning between natural science (IPA) and social science (IPS), thus forming a discipline called IPAS. IPAS learning develops literacy and numeracy skills, as well as scientific attitudes such as curiosity and critical thinking (Suhelayanti et al., 2023). IPAS learning allows students to gain direct experience and practice in discovering various concepts in a meaningful, authentic and active way (Lein et al., 2024).

Through IPAS, learners are expected to have connected and more holistic knowledge. To achieve this,

How to Cite:
Wulandari, R. D., Hastuti, W. S., Zahra, M., Nurul, S., Damayanti, I., Mirza, A. N., & Dewi, I. P. Development of Experiment-Based IPAS Exploration Sheet (LEPAS) on the Material of the Effect of Force on Objects. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 448-458. https://doi.org/10.29303/jppipa.v11i3.10211

several strategies can be applied, including learning approaches that are relevant to real-life contexts, the use of innovative educational technology, and the development of learning modules with student development. The goal is to learn and understand the subject matter or knowledge provided by the teacher well, regardless of various tools, one of which is learning media (Febriannisa et al., 2023). Within the framework of this curriculum, science learning is one of the important components that must be developed so that students can understand the basic concepts of science that are relevant to everyday life.

Effective science learning does not only depend on theory, but must also include approaches that allow students to be directly involved in experiments and observations. Sulthon (2017) says that science learning must be in accordance with the nature of science itself, that science learning must occur scientific processes, produce scientific products by conducting experiments and the formation of scientific attitudes.

Science invites students to observe natural phenomena, students get opportunities and encourage them to strengthen their knowledge. Studhalter et al. (2021) revealed that science materials greatly affect learners' daily lives. It encourages students to use scientific techniques such as observation, hypothesis formulation, and inference when studying phenomena in their environment. As a result, effective science learning can trigger students' better thinking level, which has an impact on their personality development. If students are involved in the scientific research process, learning becomes more relevant and meaningful. Given how important science is to students, it should be well mastered and presented in a fun way. This will increase students' desire to teach (Wulandari et al., 2022).

The science learning process in elementary schools involves interaction between students and the environment. Ishak et al. (2021) explains that there are several problems with science learning in primary schools. These include the idea that science lessons are scary, fear of asking questions, difficulty solving problems, and difficulty for teachers to design and select contextual problems. The learning media used by teachers are often incompatible with the way students think and develop. Therefore, media selection is very important.

Learning media is very important to help teachers deliver lessons (Kotimah, 2024). Media is very helpful in learning activities to improve student learning outcomes because learning media helps students to get information. Media can overcome the limitations of teachers in conveying information with certain words or sentences. In order for the learning process to be fun and not boring, the media must be creatively designed with simple technology and techniques. The selection process is an important part of supporting learning outcomes at school.

The selection of science tools in elementary schools (SD) is still not effective. The media used focuses more on theory than practice, which causes inhibition of students' abilities (Ayurachmawati, 2022). Lack of scientific process in science learning, even though science should be identical to experiments. The lack of maximum effort from teachers often causes learning to be monotonous. Science learning should be useful for life. The use of science media effectively improves the cognitive process, as it allows them to be actively involved in the learning process and improve their critical thinking skills. Wisudawati (2014) says that experimental activities are very suitable for science learning because they have an impact on the thinking process. In addition, many obstacles will occur if monotonous learning is maintained. Updates and presentations can be a captivating day. Interesting media makes learning more fun and memorable. Therefore, innovative and interesting supporting media is needed as a solution.

Based on the results of observations and data processing in class IV SD Al Islam Yogyakarta on September 18, 2024, as many as 17 students with 8 boys and 9 girls, students lack understanding of the material, especially in science subjects. According to the teacher, this can be seen from the low interest in learning and difficulty digesting the material. Observations also showed that when the teacher used the lecture or storytelling method and showed videos from YouTube, some students seemed less enthusiastic.

Based on the data, learning media plays an important role in schools, but there are still many educators who have not developed it. They tend to rely only on textbooks from the government or take materials from the internet without making modifications. One of the obstacles to developing learning media is due to inadequate school facilities and practicum, science, becomes a problem. Teachers also said that the learning theme that is difficult to teach is the effect of force on objects, due to the lack of learning media and practicum activities available to students. So that learning seems more monotonous.

Seen from the explanation above, the solution to the problem is to use media that supports the process of exploration and understanding of scientific concepts. Dewi et al. (2024) revealed that learning media plays an important role in achieving learning objectives, and one of the media that can be developed is LKPD. A well-designed LKPD can create an effective learning process. Experiment-based Learner Worksheets (LKPD) is one of the media that can be used to improve students'

understanding of the material being taught, especially in the topic "The Effect of Force on Objects".

Experiment-based LKPDs provide opportunities for students to actively engage in practicum activities that allow students to directly observe phenomena related to the effect of force on objects. Through this activity, students not only learn theoretical concepts, but can also experience firsthand how these concepts are applied in real life. The science learning questions included in the LKPD are also designed to stimulate students' critical and analytical thinking, as well as to deepen their understanding of the material being taught. Experiment-based LKPDs provide various benefits, such as helping students understand data concepts and scientific methods, improving academic performance, increasing student activity, and maximizing learning outcomes (Pulungan et al., 2020).

Lestari's research, E. A. (2018) on IPA LKPD found that it received a positive response. This is in line with the research of Prabandari et al. (2022), who conducted a limited effectiveness test on science experiment-based LKPD for science learning in elementary schools. The results showed that the LKPD made could be used well during the learning process. In research conducted by Hardianti et al. (2021), the results of the expert validation test were very feasible and very good in the response test. This study also shows that experimental media development needs to keep up with technological advances.

Then the research conducted by Sulasriani et al. (2023) found that the use of LKPD had a good impact on learning. Learning tools encourage students to actively learn material through practical activities or interaction with the surrounding environment is a resource that can be averaged in cycle 2 increasing from 52% in cycle 1 to 86%. Utilizing LKPD developed or designed by the teacher can increase student interest in learning. The development or design of LKPD can be adjusted to the conditions of the school and its environment (Aldiyah, 2021).

The results of the problem analysis show that there is a need for media for science materials, especially about the effect of force on objects experimentally but still with tools and materials that are easy to find. Given the importance of practicum activities in science learning as discussed.

This research has a novelty in the development of an experiment-based IPAS Exploration Sheet (LEPAS), which is designed to align science concepts with experimental practices that can be directly explored by students. The innovation in this study is the use of LEPAS that allows students not only to understand the concept of the effect of force on objects in theory, but also involves them in direct experiments that encourage a deeper and more applicable understanding. The experiment-based IPAS Exploration Sheet (LEPAS) is equipped with attractive picture illustrations, traditional games, and contextual stories.

The importance of this research lies in the effort to improve the effectiveness of science learning in primary and secondary schools by providing more interactive and applicable media. By introducing experiment-based LEPAS, this research is expected to help students develop critical and scientific thinking skills, which are indispensable in today's information and technology era. In addition, this research also contributes to the development of learning media that can be adapted to the IPAS curriculum that is being implemented, so that it can answer the growing educational challenges. Therefore, researchers are interested in conducting development research with the title "Development of Experiment-Based IPAS Exploration Sheets (LEPAS) on the Material about the Effect of Force on Objects".

Method

The research method used is research and development (R&D), which is the process of making new products or improving existing products and then testing their effectiveness (Salsabila et al., 2023). This research was conducted at Al-Islam Elementary School in Yogyakarta during the first semester of the 2024/2025 academic year (September-December 2024). The research subjects consisted of 17 students (8 boys and 9 girls) and the class teacher. The characteristics of grade IV students show diversity in interests, styles, and learning abilities. The research location was chosen based on an analysis that revealed low interest in learning science among students, lack of experiment-based learning media, and limited practicum facilities at school. The research used the 4D development model by Thiagarajan et al. (1974) which consists of four stages: Define, Design, Develop, and Disseminate.

Figure 1. Stages of the 4D development model

This research was only carried out up to the third stage, namely development. The sequence of implementation of this research starts from the Define stage. The Define stage is useful for collecting various information about the product to be developed and finding and defining learning requirements related to the product to be developed (Arkadiantika et al., 2020). At this stage, researchers conducted an initial analysis through observations and interviews with teachers and students of class IV SD Al-Islam Yogyakarta to identify

the needs of science learning, especially in the material "The Effect of Force on Objects". Furthermore, this stage also includes analyzing student characteristics, learning tasks, materials and formulating learning objectives.

Furthermore, the Design stage, there are several activities carried out as follows: making a criterion test to change behavioral objectives into an outline for instructional material or to provide specific knowledge or information to be achieved; media selection to select appropriate media for presentation, format selection or format selection (Harjanto et al., 2023). At this stage the researcher designs learning media in the form of experiment-based Learner Worksheets (LKPD), which are named experiment-based IPAS Exploration Sheets (LEPAS). The design includes media selection, format, and initial drafting using the Canva application, equipped with interesting illustrations, traditional game-based experiments, and contextual stories. At this stage also the preparation of validation instruments that will be used.

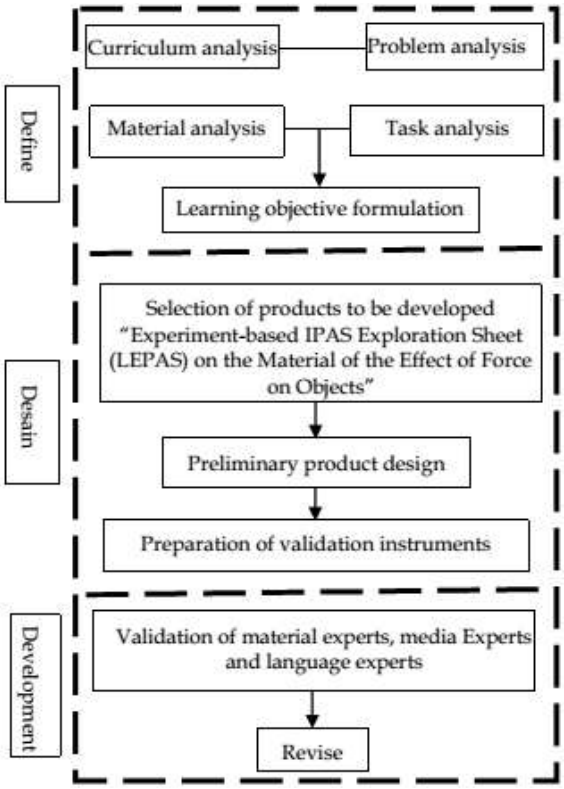

Figure 2. Research steps

The third stage, known as the development stage or Develop stage, aims to produce the amended learning by considering feedback from experts (Arum, 2020). In the Develop stage, the initial design of the Prototype was validated by three groups of experts (material, media, and language). The validation instrument used refers to the BSNP criteria. The purpose of expert validation is to collect criticisms and suggestions for improving learning devices (initial draft or draft I), so that draft II is made which is good and suitable for field trials (Widiyasari et al., 2020). The steps of this research stage can be seen in Figure 2.

This research did not reach the disseminate stage due to limited time, cost and energy so that the research focused on the development stage without conducting a trial stage. The disseminate stage is a recommendation for further research so that the product can be applied more widely. What can be done at this stage includes three main activities: first, validation testing to test the effectiveness of the product; second, packaging to package the product in an easy-to-use format; and third, diffusion and adoption to disseminate and ensure the product is accepted by users.

Result and Discussion

This study aims to develop an experiment-based IPAS Exploration Sheet (LEPAS) for the material of the Effect of Force on Objects. This development follows the 4D development research model which follows four stages, namely the define stage, design stage, development stage, and dissemination stage, but in this study researchers only reached the third stage. The following are the results and discussion at the define stage, design stage, and development stage.

Results of the Define Stage

The initial stage of this research was to identify the main problems in the learning process at SD Al-Islam Yogyakarta, especially in class IV science subjects. Based on interviews with teachers, it was found that the curriculum used was still in the adjustment stage, and the existing Learner Worksheets (LKPD) were not experiment-based. Teachers mostly rely on learning modules from online sources and traditional methods such as lectures, which do not support the development of critical thinking skills and active involvement of students.

In addition, although 75% of students achieve good learning outcomes with an average score above the Minimum Completion Criteria (KKM) of 75, 25% of students have difficulty in understanding and remembering concepts, especially in science materials. Observations showed a diversity of learning preferences: 70% of students preferred hands-on activities (kinesthetic learning style), 20% preferred visual media, and 10% were more responsive to group discussions. Students also liked learning by using game models. However, students' interest in science is generally low due to the lack of interactive and interesting learning materials. Teachers have actually conducted several experimental activities on science

learning materials but are still limited due to lack of access to the tools and materials needed in experimental activities. Whereas the use of appropriate LKPD can increase students' understanding in depth, one of which is on science material.

To improve students' understanding of science materials, especially for those with kinesthetic learning styles, it is recommended that the Learner Worksheet (LKPD) be redesigned to support experimental activities and the development of critical thinking. Research by Prabandari et al. (2022) showed that the development of science experiment-based LKPD is effective in increasing students' interest in learning in elementary schools. In the study, the LKPD was developed with a science experiment approach that suits students' kinesthetic learning style, so that it can increase their interest and understanding of science materials.

IPAS (Natural and Social Sciences) learning is presented in two separate subjects, namely science and social studies, with science learning taking place for five hours per week in semester 1. The materials and media used must be presented accurately to help students understand the concepts well (Lubis et al., 2020). The teacher identified that the material "The Effect of Force on Objects" is one of the materials that is difficult for students to understand. Meanwhile, the flow of learning objectives (ATP) for the material "The Effect of Force on Objects" is presented in Table 1.

Table 1. The Flow of Learning Objectives (ATP)

Element	Learning outcomes	Learning objectives
IPAS (Science and Social)	Experiment with muscle force, friction force, magnetic force, spring force, and gravitational force in their effects on objects	Learners can experiment with different types of forces and their effects on objects; Learners conclude the concept of different types of forces based on the results of experiments conducted

Based on the define stage above, the researcher concluded to develop LKPD learning media with several characteristics that will be conveyed at the design stage.

Results of the Design Stage

Based on the results of the needs analysis above, researchers plan to make the final product by combining text and images according to student (Anggraini et al., 2024). Researchers decided to develop experiment-based science LKPD learning media with the title Experiment-Based Science Exploration Sheet (LEPAS) on the Material Effect of Force on Objects. The characteristics of the Experiment-Based Science Exploration Sheet (LEPAS) developed are as follows:

There are various traditional games that are integrated into science learning

The integration of traditional games is carried out in force experiments conducted by students. This is based on the findings at the define stage, namely that students are very motivated when the teacher uses the game method. Traditional games include boi-boian games and rubber band games. The reasons for choosing to integrate traditional games in LKPD LEPAS are: 1) Traditional games have a great impact on child development. In accordance with the opinion of (Dharmamulya, 2004) who explained that traditional games have a great influence on children's future development in terms of psychology, nature, and social life; 2) Learning methods with games can increase children's interest in learning. Sudono (2000) states that children have the opportunity to learn through play and gain many ideas and understanding; 3) Preservation of traditional games. Many traditional games are almost extinct because in this modern era students are more familiar with electronic games, while traditional games are the culmination of all cultural (Alif, 2006).

Using tools and materials found at school and at home

One of the characteristics of LKPD LEPAS is the use of materials that can be accessed by students anywhere, both at school and at home. This is in accordance with the results at the define stage where teachers still have difficulty accessing tools and materials The weakness of the experimental method is that the necessary equipment and materials are not always available and cheap (Komisia, et al,. 2019). This can be overcome by using tools and materials found at school and at home. In line with the opinion of Tiak et al. (2019) who stated that one of the alternatives to overcome the limitations of tools and materials provided by schools, is to conduct experiments based on natural materials or other materials that are easily found in the surrounding nature at an affordable price.

There is sustainable literacy/reading of stories

The use of reading materials in the form of stories is one of the characteristics of LEPAS LKPD. The use of stories is used to explain each style material and is considered to improve students' cognitive abilities. Indarwarti (2018) explains that the story method has the potential to improve students' cognitive intelligence because it allows them to recognize forms of expression, foster imagination, strengthen memory, and open minds to become smarter and more critical. In addition, the use of continuous sentences creates stories written in a

continuous or concurrent style. This is due to the fact that students, especially primary school students, more easily understand concepts as a whole or holistically (Ubabuddin, 2019).

Based on these characteristics, researchers developed an Experiment-Based Science Exploration Sheet (LEPAS) on the Material Effect of Force on Objects through the design stages. At the media selection stage, the media developed is tailored to the needs of students through teacher analysis in IPAS learning. Based on these considerations, the media to be developed is the experiment-based LKPD IPAS learning media with the title Experiment-Based Science Exploration Sheet (LEPAS) on the Effect of Force on Objects. Furthermore, at the format selection stage, the presentation of learning media is adjusted to the direction and learning material (Husen et al., 2020). A good worksheet format must contain a title, instructions for use, competencies achieved, clear and supportive information, exercise questions, work steps, and evaluation (Nuriantisyah et al., 2023). The preparation of the format is certainly assisted by consultation with the media feasibility team. This aims to make the preparation of worksheets more structured in accordance with learning objectives and create attractive in terms of color, illustrations, layout, and worksheet content. As for the format selection, researchers are guided by the flowchart shown in the figure 3.

The selection of the format of the IPAS Exploration Sheet is in accordance with the flowchart that has been designed. The LKPD design was developed using Canva media. This makes the IPAS Exploration Sheet format attractive in terms of color, illustrations, layout, and worksheet content. The IPAS Exploration Sheet media is A4 paper size equipped with image illustrations, attractive colors with a blue color theme. The typeface is presented using andika type. The first sheet contains a cover page consisting of Title, school name, class and phase. The second sheet contains student identity. The third sheet contains an introduction with sentences and words that have been assembled by the author. The next sheet contains CP or Learning Outcomes and TP or Learning Objectives on the material The Effect of Force on Objects. The fourth sheet contains activity instructions. Students are asked to follow the instructions so that students do not feel confused when working on the experiment-based exploration sheet. On the next sheet, which contains the force material, this force material is divided into several parts including: push force, pull force, gravity force, friction force, magnetic force. These material sheets will later become several special sheets to be used as force material filler sheets according to the various forces. The next sheet is sports activities. Then the next sheet is about the stages or steps taken by students to conduct experiments related to force material. The next sheet is provided as a preparation sheet for the project report when students have completed the experiment, each group is asked to prepare a project report. The project report contains: Title of the experiment, Purpose of the experiment, Tools and materials, Experiment steps, Observation results (can be in the form of tables or graphs), Conclusion. The next sheet is a reflection and conclusion sheet. After all groups have presented their projects, the teacher gives feedback. The last sheet is an assessment sheet, so on this sheet the teacher can write and can assess the results of group work and learning outcomes that have been carried out by students regarding strength materials.

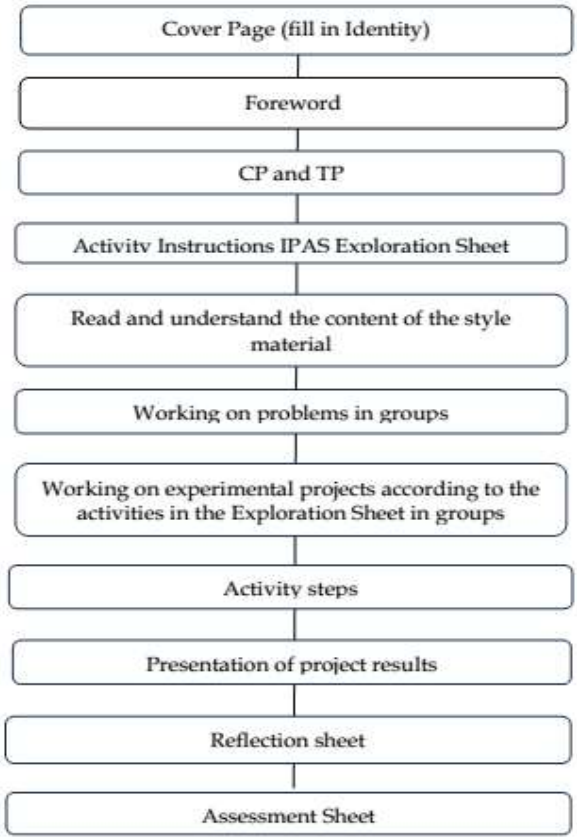

Figure 3. Flowchart

Results of the Development Stage

In the development stage, researchers make media designs that have been designed previously, then test their validity to material experts, media experts and linguists before using them in learning (Sari et al., 2024). Validation is used to provide assessments, comments, and suggestions regarding the media that has been prepared so that it is suitable for use (Juliati et al., 2024). This validation uses the Experiment-Based Science Exploration Sheet (LEPAS) LKPD media instrument to be recognized for its validity. Validation was carried out by Yogyakarta State University lecturers and carried out

during one validation. The validation results are in the tables 2, 3, and 4.

Table 2. Material Expert Validation

Criteria	Indicator	Presentation
Content suitability aspect	Material suitability with CP and ATP; Accuracy of material; Material update.	100
Presentation appropriateness	Presentation Technique; Coherence and Order of thought flow.	95
Experiential learning model aspect	Preparation stage; Information search Stage; Experimentation Stage; Follow-up stage.	90
Average percentage		95

Table 3. Media Validation

Criteria	Indicator	Percentage
Graphic Feasibility Aspect	Size of LKPD	93.9
	LKPD Cover Design	86.6
	LKPD Content Design	91.4
Average percentage		90.66

Table 4. Language Validation

Criteria	Indicator	Percentage
Aspect of Language Suitability	Simple	88.3
	Communicative, Dialogical, and Interactive	93.3
	Suitability for learner development	80
	Conformity with language rules	80
	Use of terms, symbols, or icons	100
Average percentage		88.33

Based on this table, it is obtained that the calculation results of the percentage of material expert validation obtained 95% with very valid criteria, media expert validation obtained 90.66% with very valid learning media criteria, linguist validation obtained 88.33% with very valid learning media criteria based on the calculation table. Thus, it can be concluded that the media product LKPD Experiment-Based Science Exploration Sheet (LEPAS) material "The Effect of Force on Objects" for class IV elementary school has been recognized for its validity and declared valid.

Tested Design Results

The results of the tested design of the IPAS Exploration Sheet (LEPAS) can be seen in figure below.

Figure 4. Cover

Figure 5. Book Identity

Figure 6. Identity of the book user's name

Figure 7. Preface

Figure 8. Learning objectives

Figure 9. Concept map of LEPAS

Figure 10. Details of the LEPAS material

Figure 11. Activity on LEPAS

Figure 12. Contains preparation and information

Figure 13. Instructions for doing experiment one

Figure 14. Instructions for doing experiment two

Figure 15. Instructions for doing experiment three

Figure 16. Contains triggering questions

Figure 17. Steps to play a traditional game

Figure 18. Having a discussion

Conclusion

Experimental-based LEPAS (IPAS Exploration Sheet) products have characteristics that can support the interest and contextually of science learning by designing media that are integrated with traditional game activities. Experimental tools and materials easily available around the school also add to the advantages of this media. Researchers designed reading materials designed to have a storyline so that the readings contained in the media can be connected to each other even though in different activities. Experiment-based LEPAS (IPAS Exploration Sheet) products on the material of the effect of force on objects in class IV SD Al-Islam Yogyakarta obtained a validity value by media experts with a total percentage of 95%, by material experts with a total percentage of 90.66% and by linguists with a total percentage of 88.33%. From the results of these percentages it can be interpreted that the experiment-based LEPAS (IPAS Exploration Sheet) developed by researchers occupies very valid criteria. So it is very feasible and can be tested on grade IV students in classroom learning activities. In this study, the research only reached the expert assessment development stage. Researchers suggest and recommend that further research can continue this research until the development stage of the development trial.

Acknowledgments
The author would like to express her deepest gratitude to Mrs. Woro as the supervisor of the methodology course, the friends from the master program of basic education at Yogyakarta State University who participated in completing the writing of this article until it could be published. The researcher is very happy to be able to complete this article on time.

Author Contributions
Conceptualization, IPD, ID methodology, WSH validation, MZ, ANM formal analysis, RDW investigation, SN resources, ANM and ID data curation, IPD: writing-preparation of the original draft, MNS and RDW; writing-review and editing, MZ, IPD, SN: visualization, and All authors have read and approved the published version of the manuscript..

Funding
This research was independently funded by the authors with no support from external funding agencies. Funding came from the personal and collective contributions of the research group members, the authors would like to thank all team members who have contributed financially and non-financially to the smooth running of this research. All views, results and conclusions presented are solely the responsibility of the authors.

Conflicts of Interest
The implementation of the research that we have done is running properly, the contribution of group colleagues is very good so that this research can run smoothly.

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