Development of Science Student Worksheets based on a Scientific Approach to the Topic of Light and Its Properties for Grade IV Elementary School Students

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Abstract. This research is motivated by the lack of student learning resources in schools that only use textbooks as the main source, the findings of the use of student worksheets used also do not accommodate students' critical thinking skills. This research aims to produce a product in the form of science student worksheets based on a scientific approach, especially on the material of light and its properties. This study uses the development method with the ADDIE model. The source of data in this study was fourth-grade elementary school students. The research instruments were validation sheets and teacher and student response questionnaires. The data is collected by testing the products that have been produced to determine the validity and practicality of the products that have been made. Research data were analyzed using descriptive statistical techniques. The results showed that the science student worksheets developed had a validity level with a percentage of 98.61% in the very valid category, while the practicality produced based on limited trials obtained a percentage of 92.2% in the very valid category, so it can be concluded that the worksheets of Science students based on a scientific approach are very valid and practical to use in the learning process.

Keywords: First Keyword, Second Keyword, Third Keyword.

1 Introduction

Natural Science (IPA) is a substantive subject about how to systematically find out about nature[1], [2]. According to some expert opinions, science is one of the subjects taught at every level of education, one of which is elementary school education. Science learning in elementary schools is intended to instill various sets of scientific knowledge obtained through facts, concepts, principles, and laws[3]–[5]. The application of science learning materials at the elementary school level contains a systematic thinking framework to strengthen scientific competencies and talents for elementary school students so that the learning direction is focused on the good practice of sys-

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tematically searching for natural phenomena. In line with this, several studies have revealed that science is a subject that studies phenomena through observation and experimentation so that it becomes a means for students to develop their competence.[6]–[8]. Thus, it is not uncommon for material in science subjects to have diversity by the basic objective of forming science attitudes. Some science materials that make it possible to develop students' abilities in researching and seeking the truth from natural phenomena that occur in everyday life are the topic of light and its nature.

The topic of light and its properties has many studies that can be used as a vehicle for proof in ways that science works, such as some interesting phenomena such as the direction of propagation of light that propagates straight, light that can penetrate clear objects to the refraction of light. Several topics of study of light are examples of studies that require special tricks to develop the attitude of young scientists, as well as the thoroughness of students in scientifically proving the reasons why light travels straight, can penetrate clear objects and can be refracted. Several ways that can be done to familiarize observation and research activities in proving answers to scientific phenomena are to use student worksheets that are devoted to science subject matter.[9]–[11]. Student worksheets are guidelines that contain activities, materials, and various steps that can be used as a guide for students in making observations, simple experiments, and many other things in the learning process in class. Some expert opinions suggest that student science worksheets are understandings that are used to investigate and solve problems[12] [13], [14]. Based on the opinions of these experts, it can be concluded that science worksheets are lesson sheets needed by students in the learning process. Students not only listen to the teacher's explanation but also carry out observation, and experimentation, identifying and also record research results on the Science Worksheet.[15]–[17]. The use of media and learning resources in the form of science worksheets that guide students to study independently will be more effective. In addition to studying independently, students can also play an active role in participating in the learning process, in this case, the students themselves are looking for solutions to the problems they face, and the teacher only acts as a facilitator for students. Science worksheets are used to assist students in carrying out assignments in class and outside of class.

The ways of learning science described above, unfortunately, are not following the realities that occur in the field. Based on the results of a preliminary study that was conducted in one of the elementary schools, several facts were obtained related to science learning in elementary schools. The existence of findings related to the use of student science worksheets which only contain questions became one of the things that caught the attention of researchers. In addition, the development of science worksheets that are adapted to the characteristics of students and by science learning objectives has not been found. Another phenomenon was found in several processes of implementing science learning that only used conventional methods so that learning was only teacher centered. The lack of practicum activities and simple experiments was also found in this initial study. Besides that, the results of interviews with the author and fourth-grade students they want interesting learning, not only in the form of a book full of questions but also in the form of colorful pictures and writing. This

can also be seen in the IPA worksheet they use. Most of them contain only questions, the material is only a little. There are some visible images, but most of them are fuzzy and colorless.

The phenomenon of presenting science learning as described above is strengthened by several previous studies [18]–[21]which revealed that the science worksheet currently circulating contains a collection of questions and a summary of the material that students must work on in class or as homework. 2) if the science worksheet only contains a collection of questions, then it is called an assessment sheet, the science worksheet should be in the form of work steps based on student activities to complete a task. 3) the current IPA worksheet does not pay attention to the characteristics of SD/MI children as seen from the appearance of the IPA worksheet layout. Science Students' worksheets with a full text whose letters are too small, black, and white, and have few or no pictures on one page. This shows that the science worksheet in terms of appearance is less attractive and not by the characteristics of children who like bright colors and pictures. The findings of other science problems based on the results of the preliminary study stated that many teachers present science learning in conventional ways that do not maximally invite students' critical thinking, the lack of simple experimental activities, and the lack of observational activities to hone basic science process skills are also rare. The large number of findings in the presentation of science learning that are not following the objectives and directions of learning, makes researchers feel worried if they do not find a solution immediately. Based on the results of the needs analysis revealed, the teacher's need for science worksheets can provide a better learning experience, by containing simple experiments and experiments for students to prove the truth of phenomena that occur in everyday life. and the lack of observational activities to hone basic science process skills is still rare. The large number of findings in the presentation of science learning that are not following the objectives and directions of learning, makes researchers feel worried if they do not find a solution immediately. Based on the results of the needs analysis revealed, the teacher's need for science worksheets can provide a better learning experience, by containing simple experiments and experiments for students to prove the truth of phenomena that occur in everyday life. and the lack of observational activities to hone basic science process skills is still rare. The large number of findings in the presentation of science learning that are not following the objectives and directions of learning, makes researchers feel worried if they do not find a solution immediately. Based on the results of the needs analysis revealed, the teacher's need for science worksheets can provide a better learning experience, by containing simple experiments and experiments for students to prove the truth of phenomena that occur in everyday life.

The best possible solution for activating science learning in elementary schools, especially in light material, is to develop student science worksheets based on a scientific approach. The development of science worksheets based on a scientific approach is very useful for students in terms of training students' sensitivity to problems that occur around us. The scientific approach will familiarize students with gathering information through asking, researching, and reasoning activities. The existence of basic knowledge by students, makes students have high self-confidence in participating in learning [22][23][24]. The scientific approach is also useful for fostering

students' ability to communicate and argue. This ability will be trained during the learning process because students will be trained to communicate the results of their research when they receive materials from their friends. This habituation will have a positive impact on students who are responsible, polite, tolerant, and courageous.

Different from previous research, this research develops student worksheets which are equipped with scientific approach steps so that they can guide students to carry out experiments easily. This study aims to develop science worksheets for elementary school students based on a valid and practical scientific approach to be used in the learning process.

2 Methods

2.1 Research Design

This research uses research and development methods using the ADDIE model which includes five steps, namely analysis, design, development, implementation, and evaluation. However, in this study, it was only limited to the development stage. The analysis stage is carried out by analyzing the needs of teachers and students for teaching materials or learning tools which are carried out by interviews guided by interview guidelines, besides that, analysis of the curriculum and characteristics of students in grade IV elementary schools is also used as the focus of needs analysis studies to produce products that are according to the stage of development. The design stage is carried out by designing products to be produced based on specifications and advantages that are following the needs of teachers, students, and the curriculum. At the development stage, product validity is carried out which includes graphics, material content, and language, and practicality tests are carried out for teachers and students related to products that have been produced.

2.2 Instruments

The research instrument used was a teacher and student response questionnaire. Apart from that, other instruments also use media validity and practicality sheets.

2.3 Data Collection

The data collection instrument in this study used interview guidelines to obtain data at the analysis stage, as well as the validity and practicality sheets of the developed student science worksheets.

2.4 Data Analysis

Data analysis was performed using descriptive statistical analysis with percentage techniques. Interpretation of data is carried out based on percentage size with conditions, invalid if the resulting percentage ranges from 0 - 2-%, less valid if the assess-

ment percentage is in the range of 20 -4-%, quite valid with a percentage of 40 - 40%, valid with a percentage of 60 – 80%, and very valid if you get a percentage score of 80 – 100%. The same thing also applies to the practicality interpretation of the product used

3 Results and Discussion

Based on the results of data collection that has been carried out, the results of research related to the development of student science worksheets based on a scientific approach for grade IV elementary school students are obtained, as follows.

3.1 Analysis Stage

The first needs analysis is carried out by seeking information related to the needs of teachers and students regarding the form and format of student science worksheets that are attractive and appropriate to use. Based on the results of the interviews, was obtained an explanation from the teacher said that during the teaching and learning process the teacher used theme books and science student worksheets. However, teachers often use science student worksheets. However, the science student worksheet contains only a small amount of subject matter and only focuses on questions and exercises. Often the teacher only asks students to work on the questions contained in the science student worksheet. The science student worksheet used by students so far has not activated students in participating in learning, students find it difficult to work on the questions contained in the LKPD because there is only a small amount of learning material, so it needs to be developed by containing scientific activity steps such as simple experimental examples and other field observations to instill basic science skills in students' process skills. This is in line with the needs of the students. Based on the results of the interviews conducted, it was found that they wanted interesting learning, not only in the form of a book full of questions but also in the form of colorful pictures and writing. This can also be seen in the LKPD they use. Most of them contain only questions, the material is only a little. There are several pictures visible, but most of the pictures are not clear and colorless, so students need worksheets that are appropriate to their stages of development, such as full colors and pictures, as well as full practicum activities.

The stages of analysis are continued with curriculum analysis by mapping basic competencies, indicators, and learning objectives. Based on Core Competencies (KI), basic competencies (KD), and existing indicators, the concept of learning material will be obtained which is arranged systematically. The concept material on the properties of light is arranged sequentially and presented in six simple discussion points, coupled with supporting pictures, and variations in letters and text colors that are appropriate to learning and increase student interest in learning. At this stage, the materials that will be included in the LKPD are detailed. The material is based on KD and indicators that have been done before. In addition, researchers also used a five-stage scientific approach. From the KD mapping and indicators that have been carried out, the researcher divided the material into six lessons. The six lessons consist of, the first lesson discusses light material, lesson 2 discusses light propagating straight, les-

son 3 light penetrates clear objects, lesson 4 light can be reflected, lesson 5 light can be refracted, learning 6 light can be reflected. Each lesson will contain 5 steps of the scientific approach. The time allocation used in delivering one lesson is 1 X 35 minutes.

3.2 Design Stage

At this stage, the design is carried out based on product specifications from the results of the needs analysis, a description of these stages is shown in table 1 below.

Table 1. Aspects of product design Sains worksheet

No	Aspect	Description
1	Front cover	Title: Scientific Approach-Based Science Worksheet on light and its properties for fourth-grade elementary school students.
2	Prefilled section	This section contains: a. Foreword b. Study Guide c. List of contents d. Basic Competency Mapping and Indicators
3	Contents section	This section contains: a. Lesson 1 – Light b. Lesson 2 – The Nature of Straight Traveling Light c. Lesson 3 – The Nature of Light Penetrating Clear Objects d. Lesson 4 – Light can be reflected e. Lesson 5 – Light can be refracted f. Lesson 6 – Light can be described g. Evaluation h. Formative Assessment

A display of the design results of each item based on table 1 above, can be seen in the following figure.

(a) (b) (c)

Fig. 1. Cover Display (a), Learning Instructions (b), and Basic Competency Mapping (c)

The contents of this LKPD contain 6 lessons, evaluation questions, author profiles, and a bibliography. The contents of this LKPD contain steps, instructions, and experiments as well as materials and tools needed by students to carry out experiments. In each activity there are five steps to the scientific approach, the five steps are observing, asking, reasoning, trying, and communicating. The following is a display of student science worksheets based on a scientific approach as shown in Figure 2 below.

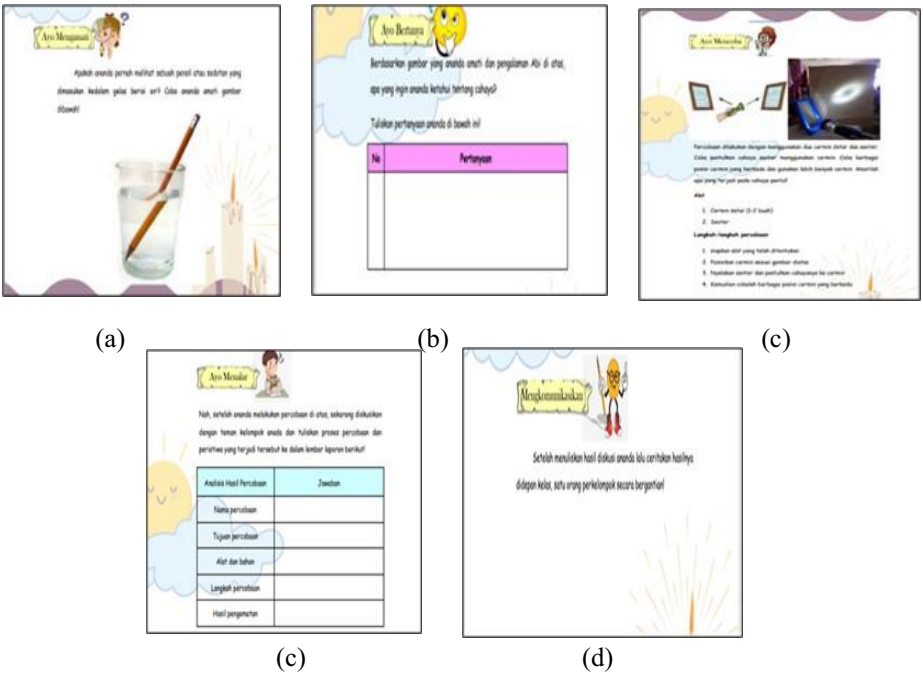

Fig. 2. Display of student science worksheet activities adapted to scientific steps, observing (a), asking questions (b), trying or experimenting activities (c), reasoning activities (d), and communicating results (e).

The first stage of the scientific approach found in every activity in the LKPD product is observation. In this picture, students are led to make observations on the pictures that have been presented. The second stage of the scientific approach that is found in every activity in the LKPD product is asking. This activity aims to invite students to ask questions about things they do not know through observation. The third stage of the scientific approach that is found in every activity in the LKPD product is reasoning. This activity aims to guide students to write down the results of observations and experiments that they have done in learning activities. The fourth stage of the scientific approach contained in each activity in the LKPD product is trying. In this activity, students are invited to conduct experiments to prove that the phenomena that have been observed occur and can be proven through simple experiments. In the experiment section, the researcher also gave the activity steps as well as the tools and materials needed by the students to experiment. The fifth stage of the scientific ap-

proach found in every activity in the LKPD product is communicating. Communicating activities aim to invite students to present their work in front of their friends, both individually and in groups In the experiment section, the researcher also gave the activity steps as well as the tools and materials needed by the students to experiment. The fifth stage of the scientific approach found in every activity in the LKPD product is communicating. Communicating activities aim to invite students to present their work in front of their friends, both individually and in groups In the experiment section, the researcher also gave the activity steps as well as the tools and materials needed by the students to experiment. The fifth stage of the scientific approach found in every activity in the LKPD product is communicating. Communicating activities aim to invite students to present their work in front of their friends, both individually and in groups**.**

3.3 Development stage

At this stage, the product that has been designed is then validated by three experts, namely content validity, display validity, linguistics, and graphics. The results of validation of three experts obtained the following results.

Table 2. Product Validity Results of Student Science Worksheets based on a scientific approach

name	expert	score	Assessment	Repair
Lenny Zaroha, M.Pd	language	91.7	Very Valid	Improved the writing of the IPA worksheet by changing to the comic sans ms font type
Dr. Rahmatul Hayati	Content	98.6	Very Valid	Improvements to the content of the experimental steps by separating the subtitles of the tools and materials used.
Adam Mudinillah, M.Pd	graphics	97.6	Very valid	Improvements to the image on the cover of a girl's image that is not veiled, replaced with a boy's image.
Resti Yulia, M.Pd	Appearance	92.8	Very Valid	Replacing the gradations and color blends with more shifty ones, so that they are comfortable for students to see.
Means		95,2	Very valid	module to use

After an assessment and improvement process has been carried out, the next step is to conduct a simple practicality test on three elementary school teachers who teach specifically in the science field of study. The results of the practicality test based on three teachers are obtained as follows.

Table 3. Results of teacher responses to science worksheet products based on a scientific approach

name	aspect	score	Assessment	Comment
Rindu Maulana, S.Pd	Appearance	100	Very Valid	The appearance of science students' worksheets has unobtrusive colors, lots of pictures, and work procedures that are easy for Grade IV elementary school children to understand.
Linarni, S.Pd	Content	100	Very Valid	The learning content is very contextual to everyday life, making it easier for students to understand.
Syifa Fauziah, S.Pd	Benefit	91.7	Very valid	This science worksheet helps teachers in developing science learning practices and trains students' laboratory skills and reasoning power to prove the truth of science through simple scientific research.
Means		97.2	Very practice	module for using

Practicality was continued by randomly distributing to three grade IV students in one of the elementary schools. Based on the results of student assessments regarding the practicality of scientific-based science worksheets, the results were shown in table 4 below.

Table 4. Results of Student Responses to Science worksheet products based on a scientific approach

name	aspect	score	Assessment	Comment
Muhammad Arif	Appearance	90.3	Very Valid	I like the pictures on this worksheet, it's interesting to see.
Devano Dwi Ikhsan	Content	88.2	Very Valid	The material is following the learning in the sourcebook
Latifah Hanum	Benefit	91.7	Very valid	I find it easier to do science experiments in class with my teacher and friends.
Means		90,1	Very practice module for using	

Based on the results of the validity test, and the practicality of the teacher and students, it was found that student science worksheets with a scientific approach produced valid and practical products, both in terms of teacher use and student use.

3.4 Discussion

The validity of the products produced is inseparable from product specifications that are adjusted to the needs of the field. The formulation of a worksheet that does not only contain questions, but contains student work steps is believed to be a strength in itself for the convenience of teachers and students in the science learning process in class, to serve as a guide and guide in investigating, proving, and observing the course of science learning in class.[9], [28]–[32]. In addition to containing the five stages of the scientific approach, the developed LKPD also has special characteristics, making it easier for students to work on the science student's worksheet. These characteristics, among other things, bring out elements in science learning such as those in the pictures of students' science worksheets. The first element like science is attitude. This element of attitude is reflected in observing activities, so it will bring out the curiosity of students about the learning that will be carried out**.** The second element is processed. In this process, students will carry out activities ranging from reading, conducting experiments, drawing conclusions, and communicating in front of the class. The third element is the product. After carrying out observing activities, and a series of processes in science learning, a product will emerge in the form of facts or students' understanding of the learning being discussed. The fourth element is applied. At this application stage, students tell the results of their discussions in front of the class and apply them in everyday life.

Another explanation is related to the high practicality value given by the teacher to the results of assessing the response of teachers and students, in line with the opinions and comments they expressed that, the presence of science worksheet products based on a scientific approach makes it easier for teachers to manage the course of the experiment, because it is assisted by systematic work step guidelines and following the context of students' daily lives so that this makes it easier to direct students in carrying out simple experiments. This product support essentially not only facilitates the learning process but also trains students' reasoning abilities and students' critical thinking in the process of finding out scientific truths through simple experiments carried out.[22]–[24], [33]–[36]. Based on the description above, it is clear that the development of learning product innovations in the form of learning tools, and student worksheets are an urgent need to fulfill the learning process by the output to be produced.

4 Conclusion

The development of science student worksheets based on a scientific approach to science is needed at SDN 03 Koto Lamo because there have never been developed student worksheets based on a scientific approach to the material properties of light at that elementary school. In addition, using students' worksheets based on the scientific approach can activate students in the learning process. Students will also learn independently, looking for various sources of information at school, at home, and in the community. Learning will be fun and not boring. The validation results of IPA LKPD based on the scientific approach that has been developed determine the results are very valid based on the percentage of the aspect of content validity having a validation value of 98.61%. so in this aspect, it is very valid to use. In the aspect of display validity, it has a value of 92. 85% on this aspect is very valid to use. For

linguistic validity, the value is 91.66%. The literal validity has a value of 97.62%. meaning that this aspect is very valid to use. The overall value of 95.18%, which means it is very valid to use in the learning process. The average percentage results of the scientific approach-based practicality test of LKPD IPA determine practicality results, namely 90.1% for the student response questionnaire and 97.2% for the teacher response questionnaire, with a very practical category for use in learning.

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