INDONESIAN JOURNAL OF SCIENCE AND MATHEMATICS EDUCATION
https://ejournal.radenintan.ac.id/index.php/IJSME/index
05 (3) (2022) 297-308
ISSN: 2615-8639
DOI: 10.24042/ijsme.v5i2.13779
November 2022

SCIENTIFIC APPROACH-BASED STUDENT WORKSHEET TO IMPROVE ELEMENTARY SCHOOL STUDENT'S SCIENTIFIC PROCESS SKILL

Leli Kartika[1], I Wayan Distrik[2*], Pujiati[3]
[1,3]Natural Sciences Education, Universitas Lampung, Indonesia
[2]Department of Physics Education, Universitas Lampung, Indonesia

**Corresponding author:* wayandistrik8@gmail.com

Article Info

Article history:

Received: September 16, 2022
Accepted: November 10, 2022
Published: November 25, 2022

Keywords:

Scientific approach
Scientific process skill
Student's worksheet

ABSTRACT

This research and development aim to produce student worksheets based on a valid, practical, and effective scientific approach to improve the science process skills of fifth-grade students in elementary schools. The development procedure adopted the Borg and Gall Model, which was simplified into seven steps. In the main field test phase, the research sample was 20 fifth-grade students at SDN 5 Kresnomulyo. This study uses a one-group pretest-posttest design. Data analysis used paired sample t-test to test the difference between the pretest and posttest. The results showed that student worksheets based on the scientific approach were declared valid with content validity values of 86.63 and construct validity of 85.63, practical as indicated by positive student responses, and effective as indicated by n-gain values paired sample t-test results. It can be concluded that the developed student worksheets are feasible to use and can improve students' science process skills.

LEMBAR KERJA SISWA BERBASIS PENDEKATAN SAINTIFIK UNTUK MENINGKATKAN KETERAMPILAN PROSES SAINS SISWA SEKOLAH DASAR

Kata Kunci:

Pendekatan ilmiah
Keterampilan proses ilmiah
Lembar kerja siswa

ABSTRAK

Penelitian dan pengembangan ini bertujuan untuk menghasilkan lembar kerja siswa berbasis pendekatan saintifik yang valid, praktis, dan efektif untuk meningkatkan keterampilan proses sains siswa kelas V di sekolah dasar. Prosedur pengembangan mengadopsi Model Borg and Gall yang disederhanakan menjadi 7 langkah. Pada tahap uji lapangan utama, sampel penelitian adalah 20 siswa kelas V SDN 5 Kresnomulyo. Penelitian ini menggunakan desain *one group pretest-posttest design*. Analisis data menggunakan uji *paired sample t-test* untuk menguji perbedaan antara *pretest* dan *posttest.* Hasil penelitian menunjukkan bahwa lembar kerja siswa berbasis pendekatan saintifik dinyatakan valid dengan nilai validitas isi 86,63 dan validitas konstruk 85,63, praktis yang ditunjukkan dengan respon siswa yang positif, dan efektif yang ditunjukkan dengan nilai *n-gain* dan hasil uji *paired sample t-test*. Dapat disimpulkan bahwa lembar kerja siswa yang dikembangkan layak digunakan dan dapat meningkatkan keterampilan proses sains siswa.

1. INTRODUCTION

Natural sciences are a knowledge branch studying natural phenomena and everything in nature based on observations of facts, principles, and discoveries [1]. Knowledge facts and principles produced by natural sciences are procedural, conceptual, and metacognitive knowledge that are systematically tested [2]. Natural sciences subject is the one that elementary students should master because it is the main subject in elementary school [3].

Science learning directs students to factual, conceptual, and procedural knowledge organized in an event or natural phenomenon. Science learning at the elementary school level can start from students' everyday life experiences [4]. The scope of science learning in elementary schools, namely living things and life processes; objects/materials, their properties, and uses; energy and its changes; and the earth and the universe. Substantially, science can be used to develop attitudes, knowledge, and skills. The essence of science, which is quite essential, is the dimension of the scientific process (scientific method). The point is that students learning science are not learning to memorize concepts but learning to discover through the process of science. By doing hands-on and mind-on activities based on science processes, students can understand, experience, and find answers to their problems [5]. Learning materials in natural sciences study natural phenomena, and they need more reasoning by students. The material learning characteristics of natural sciences tend to be abstract, and this makes natural science concepts difficult for some students [6]-[8].

Natural sciences have an essential role in students' intellectual development. Amongst functions of natural sciences subject are: to provide basic knowledge to continue to higher educational levels and to apply in daily life, to develop skills in acquiring and implementing natural science concepts, to grow scientific attitude and to train students in using the scientific method to solve problems, to make students realizing the orderliness of nature with all of its beauty so that students are encouraged to love and adore the creator, to develop student's creativity and innovation energies, to help students understand new notions and information in knowledge and technology, and to develop student's interest on natural sciences subject [9]. Natural sciences learning functions to make students have knowledge about natural phenomena and have skills and the scientific method through observations [10].

Based on field observation, teachers tend to be more active than students in the learning process. Learning is often delivered by talking and question and answer. Students are very passive. The teaching materials used are theoretical so that students in learning are not directly involved in observing activities, collecting data, and making conclusions. Likewise, the student worksheet used is less focused on the problems that students will solve. The student worksheet used is difficult to understand, and the applied examples are complex for students to recognize because they are never found around their area. The results of a field survey support this result: 68% of students said that the student worksheet used was difficult to understand, and 84% of students stated that the existing student worksheet was less attractive because the images displayed did not match their living environment. In learning, students only listen to the teacher's explanation, answer only when the teacher asks them to, and have no initiative to question and argue. This makes students' scientific process skills, such as students' abilities in observing, collecting data, making hypotheses, and reasoning, very low. Based on the results of preliminary research in the field, it was found that 80% of students expected that student worksheet was made by presenting easily recognizable facts or images found in their environment, and 84% of students wanted the material in

student worksheet to contain many examples in everyday life. The findings are supported by [11], which found that ethnoscience-based worksheets helped students understand science concepts. Conventional and non-problem worksheets makes it difficult for students to solve real problems, so student learning outcomes are low [12].

The results of other studies also reveal that worksheets play an essential role in increasing student learning activities. Worksheets for elementary school students must follow the culture and environment in which they live, be presented in simple language, and be easy to understand [13]. Therefore, learning material that can encourage students to be creative and critical in learning is required. Learning material becomes a reference for students in their learning processes. Learning materials can be student worksheets, teaching books, or modules. Practical learning material can be used to guide students to study actively, creatively, and critically.

The scientific approach is very following Curriculum 2013 that learning is conducted in five activity stages; asking the question, observing, trying, reasoning, and communicating. The learning process in Curriculum 2013 prioritizes learning that encourages more student activity or student-centered learning while the teacher only acts as a facilitator. The scientific approach is believed to be able to develop attitudes (affective domain), skills (psychomotor domain), and knowledge (cognitive domain) of students. Through this approach, students are expected to be able to answer their curiosity through a systematic process as well as scientific steps. In a series of scientific learning processes, students will find the meaning of learning that can help them to optimize cognition, affect, and psychomotor. The scientific approach emphasizes providing direct experience using observation, experimentation, and other methods to improve students' science process skills, such as observing, classifying, communicating, measuring, predicting, and drawing conclusions.

The use of student worksheet has a somewhat important role in the learning process, especially at the elementary school level [14]. Student worksheet can make it easier for teachers to carry out learning [15]. Student worksheet, equipped with theory, practice, and evaluation, can help students understand the material provided by the teacher so that they can optimize learning in the classroom. Student worksheet can also increase learning motivation and improve student learning outcomes in learning at school in science lessons [16]. The scientific approach is essential in guiding students to conduct observations or experiments to improve their science process skills [17]. Science process skills are needed to provide experience to students in identifying and recognizing a phenomenon or a natural event. Science process skills are also critical to be taught to students because they can train them to think at higher levels and behave actively in learning to improve the problem-solving skills they face in everyday life [18]. The scientific approach is learning that demands a student's active participation in constructing concepts, laws, or principles through observing, asking questions, collecting information, associating, and communicating [19]. A scientific approach to learning can trigger students' activity to improve students' scientific process skills. Scientific approach application in the learning process can be integrated into teaching materials such as modules, handouts, and student worksheets.

Using student worksheets is essential in learning, especially in elementary school. A student's worksheet equipped with theories, practices, and evaluations can improve students understanding of learning materials delivered by teachers to optimize students' scientific process skills. Moreover, can also enhance students' learning motivation and learning results. The scientific approach emphasizes natural learning. This approach is considered to be able to develop students' assessment in the affective domain (attitude),

psycho-motoric domain (skill), and cognitive domain (knowledge). A scientific approach is expected to answer students' curiosity systematically according to scientific processes or steps.

2. METHOD

2.1 Research Design

The scientific approach-based student worksheet (SABSW) development procedure is adapted from a development model by Borg and Gall that contains ten steps [20]. It is simplified into seven steps with some necessary adjustments (Figure 1). The primary field test uses one group pretest-posttest design.

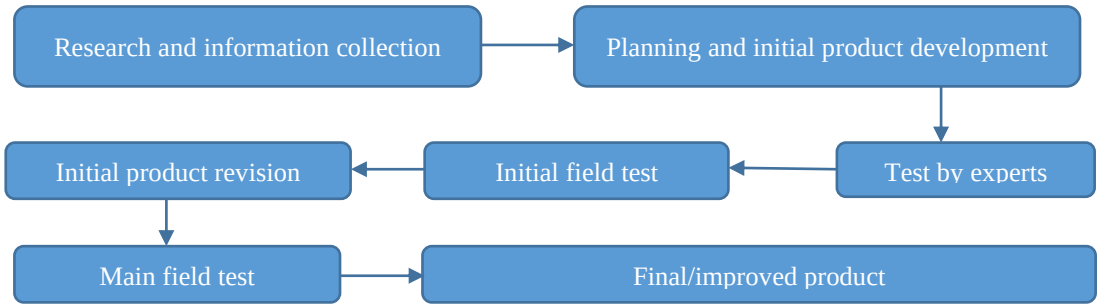

Figure 1. Development Procedure in This Research

2.2 Population and Sample

The research population is all grade V students in Public Elementary School 5 in Kresnomulyo. Samples are 20 students. A pretest is conducted before giving treatment in the experiment classroom. Posttest is given after all topics are delivered. The sample group is taught with a scientific skill approach using a scientific approach-based student worksheet (SABSW).

2.3 Data Collection

This research includes data on the validity, practicality, and effectiveness of SABSW. Validity data are collected with validation scale sheets assessed by three experts. SABSW validity contains content and constructs validities. SABSW practicality data are collected by implementation and students' responses to SABSW during learning. SABSW effectiveness data are collected with scientific process skill tests.

2.4 Data Analysis

These research and development data are analyzed descriptively. Validity data are analyzed with a percentage technique given by experts to each indicator. SABSW practicality data are analyzed with percentage technique with the following categories: very high implementation (80.1-100%), high implementation (60.1-80%), moderate implementation (40.1-60%), and low implementation (20.1-40%) [21]. Student's response is analyzed by counting the number of students choosing option *a* and *b* as positive responses and option *c* and *d* as negative responses. The positive response is when > 50% of students say that the worksheet is easy to understand, interesting, and fun. The negative response is when > 50% of students say that the worksheet is difficult to understand, less interesting, and boring. The n-gain test result of scientific process skill analyzes the worksheet's effectiveness. N-gain or scientific process skill improvement index is determined with the following formula [22].

$$< g >= \frac{\%\ posttest\ score - \%\ pretest\ score}{100 - \%\ pretest\ score} \qquad (1)$$

Table 1. Score Interpretation

N-Gain	Category
g > 0.70	High
0.30 ≤ g ≤ 0.70	Moderate
g > 0.3	Low

The difference between the pretest and posttest results is analyzed by using paired sample t-test.

3. RESULTS AND DISCUSSION

3.1 Worksheet Validity by Experts

The SABSW product validity is tested by learning material experts (content validity) and learning design experts (structure validity). The test results by experts are shown in Table 2 and Table 3.

Table 2. Test Results by Learning Material Experts (Content Validity)

Validators	Score	Max. score	Percentage
Validator 1	115	135	82.14%
Validator 2	123	135	91.11%
	Average		86.63%

Table 2 shows that learning material in SABSW complies with the update element, satisfies indicators, and actionable steps follow the model to use. According to the validator, in general, the material's description follows the demands of the 2013 curriculum. Several suggestions should be improved and added according to the student's potential, namely at the observation stage. The picture of environmental conservation (Figure 2a) is adjusted to the picture of real environmental conservation made by the students (Figure 2b).

(a) (b)

Figure 2. Validator's Suggestion (a) Reimage and (b) Replacement Image

The questioning step has not included pictures of clean and dirty water sources. Experts consider showing pictures at the questioning step important to make it easier for students to recognize clean and dirty water in their environment. Image of clean water sourced from mountain water (Figure 3a) Image of dirty water sourced from river water full of garbage (Figure 3b).

(a) (b)

Figure 3. Image revision (a) Clean Water Source and (b) Dirty Water Source

Table 2. Test Results by Learning Construct Experts (Construct Validity)

Validators	Score	Max. score	Percentage
Validator 1	71	80	88.75%
Validator 2	66	80	82.5%
	Average		85.63%

Table 3 shows that the construct validation average is very valid. The image display and explanation are appropriate. Likewise, the relationship between sentences supports each other and is easy to understand. The arrangement and selection of images displayed in the Scientific Approach-based Student's Worksheet (SABSW) follow the student's environment so that students easily recognize it. The SABSW is stated to be valid by experts regarding content and construct validities. This SABSW learning apparatus is valid because it is based on a strong theoretical base and has internal consistency, the interconnection between components in this developed worksheet [23]. Materials in this SABSW conform to basic competencies learning indicators, and mapping performance assignments is made under learning (learning 1 to learning 6). The language aspect in SABSW is accurate in its sentence structures, dictions, and sentence uses, easy to understand, using Indonesian language standard writing, using proper terms, symbols, figures, and icons.

The SABSW satisfies the rational-theoretic element, the material study and learning activity supported by learning theories such as constructivism and cognitive learning theories. It has a clear objective, easy to use by teachers, and is suitable for the learning environment. The constructivist learning theory makes students not passive in receiving information from their teacher but actively involve themselves in learning [24]. Cognitive constructivism uses the theory of information processing in learning. In science learning, students actively do activities in learning, such as observing or experimenting, collecting data, and communicating with other people.

The scientific approach-based student worksheet (SABSW) in learning has characteristics like the reaction principle–where students express opinions toward observation and analysis results; social system–where activities in SABSW enable students to cooperate, mutually help, and do correction; and supporting system – where activities in SABSW can support learning [25]. Learning material based on a scientific approach contains learning activities such as observing, experimenting, reasoning, asking questions, and communicating. These scientific activities are elaborated in teaching materials that can improve students' scientific process skills.

3.2 Product Practicality

3.2.1 Product Practicality by Educators

A limited test is done to see the SABSW practicality using the educator's response sheet. There are six educators in Gugus Melati. The result of the educator questionnaires is shown in Table 4.

Table 4. Educator's Response

No	Aspect to Assess	Educator					
		1	2	3	4	5	6
1	Attractiveness	10	8	10	11	10	10
2	Easiness	8	12	12	10	12	9
3	Usefulness	11	11	11	10	9	11
Score		29	31	33	31	31	30
Max. score		36	36	36	36	36	36
Score Percentage		80.5%	86.1%	91.6%	86.1%	86.1%	83.3%
Percentage average		85.6%					
Criterion		Very practical					

Table 4 indicates that the SABSW is very attractive, easy to use, and easy to understand because materials are presented from the easiest to understand by students up to more complex ones, and the materials follow curriculum demand in Indonesia.

3.2.2 Product Practicality by Students

After revisions based on inputs provided by teachers/users, the next test is done to 12 respondent students. The result is shown in Table 4.

Table 5. Student's Response

No	Aspect to Assess	Percentage per Aspect	Criteria
1	Attractiveness	91.33%	Very practical
2	Easiness	93.28%	Very practical
3	Usefulness	90.83%	Very practical
Percentage average		91.81%	

Table 5 shows a very positive student response. 91.81% of students say that the SABSW is delivered with attractive figures, the learning material is easy to understand, and it follows the learning objective and curriculum demand. Before doing practical activities, students are invited to identify the characteristics of some materials, such as oil and water. The characteristics of oil and water are analogous to the lives of cats and dogs who never live in harmony and always fight when they unite. Using analogies to understand the material will be easier than a direct explanation, especially in material or difficult cases for students to understand [26].

ABSW is valid and practical to use in learning. A practical student's worksheet can facilitate its users [27]. It has adaptive power toward science and technology development. Indicators of attractiveness and easiness measure SABSW's practicality and usefulness assessed by teachers and students. According to teachers and students, the SABSW in learning displays supporting figures and fonts and attracts students' reading interest. The SABSW also contains figures under the student's learning environment so that events and phenomena in this student's worksheet can be easily understood by students [28]. According to teachers and students, every activity in this worksheet follows the inductive method, where the material is presented from the simplest thing, or the observation, up to analysis. The inductive method is easier to understand students because students' understanding is built from facts to find solutions to solve learning problems. Learning materials in natural sciences require students to understand how an event happens and where the location of the event/phenomenon. Students should understand the language to use in explaining that event. The SABSW can help students observe, identify an event, group an event, review the event, and help students conclude.

3.3 Product Effectiveness

The pretest and posttest results from learning 1 to learning 6 are shown in Table 6 and Table 7.

Table 6. Pretest Result

Indicator	The Score of Each Learning						Average
	1	2	3	4	5	6	
Observing	58	59	60	55	52	52	56,33
Classifying	55	50	61	54	50	53	55,83
Measuring	57	58	61	51	61	55	58,83
Concluding	58	54	50	57	55	58	55,33
Average	57.00	57.75	55.50	54.25	54.50	54.50	56.58

Table 6 shows that the highest score for scientific process skill is in learning/meeting two, with an average score of 57.75, and the lowest score is in learning/meeting four, with an average score of 54.25. The highest indicator score is in measuring activity, with an average score of 58.83, and the lowest score is in the concluding activity indicator, with an average score of 55.33. Each average learning score is above 50. These results mean that students already have adequate basic skills in the water and its use. In the initial test, the average of each indicator is 55.33, which is the lowest score among other indicators. This is because students have difficulty analyzing data, making it difficult to make conclusions. The biggest indicator is measuring. Some students seem to have understood the volume of water needed by the body. The need for water by the human body is a form of real-life experienced by students every day, making it easier for students to understand. After all learning topics have finished discussed, the posttest is done. The posttest result is shown in Table 7 below.

Table 7. Posttest Result

Indicator	The score for Each Learning						Average
	1	2	3	4	5	6	
Observing	77	79	79	82	84	81	80.33
Classifying	71	81	82	86	85	80	80.83
Measuring	75	75	80	80	84	79	78.83
Concluding	72	72	73	74	79	72	73.67
Average	73.75	76.75	78.50	80.50	83.00	78.00	78.42

Table 7 shows that the highest score for scientific process skill is in learning/meeting 5, with an average score of 83 and the lowest score is in learning/meeting 1, with an average score of 73.75. The highest indicator score is in classifying activity, with an average score of 80.83, and the lowest score is in the concluding activity indicator, with an average score of 73.67. The low ability of students to make conclusions or interpretations in solving problems is because students have difficulty connecting between concepts. Students have difficulty connecting concepts in learning physics [29], [30]. Difficulties in making conclusions were also found in a study entitled Application of the REAL model to improve metacognition and problem solving abilities in physics [31]. The average n-gain score of scientific process skill is 0.51, which belongs to the moderate category. The n-gain indicators of scientific process skills are shown in Table 8 below.

Table 8. N-gain Scores of Scientific Process Skill

Indicators	Pretest	Posttest	N-gain
Observing	54.33	80.33	0.57
Classifying	53.83	80.83	0.48
Measuring	58.83	78.83	0.49
Concluding	57.00	73.67	0.39
Average	55.58	78.42	0.51

The paired sample t-test result indicates a significant difference (sig.2 tailed < 0.05) between the pretest and posttest results of scientific process skills. The SABSW effectively improves students' scientific process skills in elementary school. Scientific activities can improve the science process skills of elementary school students [4]. In contrast to this research which is only applied to learning with a scientific approach, our research and development include teaching materials and approaches in learning that use a scientific approach. This is quite easy for teachers to deliver material to achieve learning objectives, improving students' science process skills.

Not only be valid and practical, but a student's worksheet should also be effective in gaining learning objectives. Learning material effectiveness is measured based on scientific process skill test results. The research result shows that SABSW is effective to use in improving students' science process skills, and this is shown with an average n-gain score of 0.51, which belongs to the moderate category. This result is in line with the same study conducted by [32]. The scientific approach in observation activity can guide students to identify an event and make a conclusion [33]. Students are also able to group or classify events and make predictions. Real-life-based learning makes it easier for students to explain an event, make observations, and group examples of events or objects into similar groups [34].

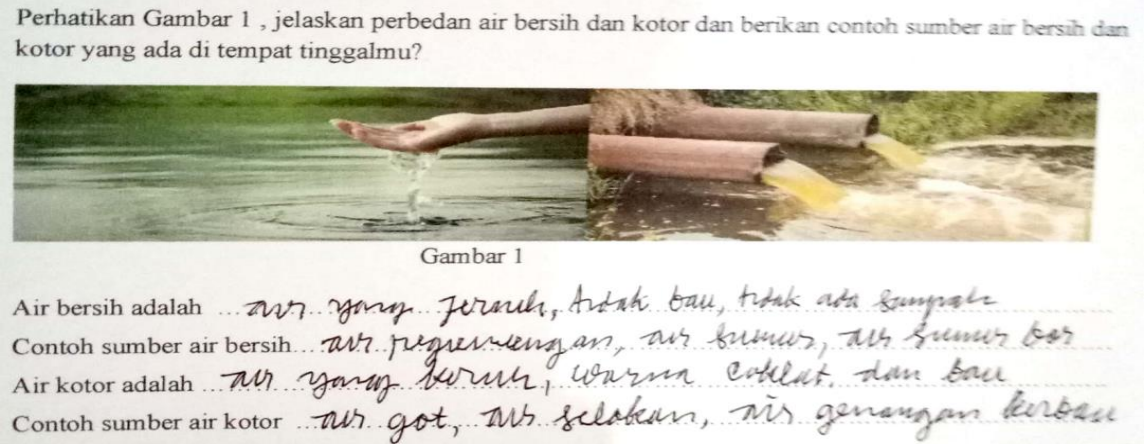

Figure 4. Examples of Students' Posttest Results

The students' answers followed the facts found in real life in their living environment, but some answered incorrectly. They said that clean water is blue water and dirty water is water that cannot be drunk. Examples of clean water come from bottles and dirty water. Comes from the river. The students who answered incorrectly seemed to be affected by the blue picture of clean water. These results indicate that students' analytical skills are still low. However, most of the students' answers indicated that Observation activity improves students' ability to identify a problem. The highest n-gain score for observation activity is 0.57, which belongs to the moderate category. N-gain of the concluding indicator has the lowest score of 0.39, but it also belongs to the moderate category [35]. The low score is because of low student ability in reasoning. Students' concluding ability in concept understanding and problem-solving are the lowest compared to other indicators [36].

4. CONCLUSION

Based on the research and development results, it can be concluded that the Scientific Approach-based Student's Worksheet (SABSW) is 1) valid to improve scientific process skills of grade V students in elementary school, indicated by the content validity score of 86.63 and construct validity score of 85.63. 2) Practical to use in improving students' scientific process skills, indicated by positive responses of 91.81% of students and 85.60% of teachers. The SABSW used in learning is easy to understand, attractive, and useful. 3) Effective to use in improving student's scientific process skills, which is indicated by the average n-gain score of scientific process skill of 0.51. There is a significant difference (sig.2 tailed < 0.05) between the pretest and posttest results.

REFERENCES

[1] Y. Suryaningsih, "Pembelajaran Berbasis Praktikum sebagai Sarana Siswa untuk Berlatih Menerapkan Keterampilan Proses Sains dalam Materi Biologi," *Jurnal Bio Education,* vol. 2, no. 2, pp. 12-19. 2017.

[2] N.W.S., Darmayanti and Haifaturramah, "Analisis Kelayakan Buku Panduan Praktikum Ipa Terpadu SMP Berpendekatan Saintifik Dengan Berorientasi Lingkungan Sekitar," *Jurnal Orbita*, vol. 5, no. 1, pp. 1-10, 2019.

[3] S. Windyariani, " Pembelajaran IPA Dengan Praktikum Berbasis Konteks Dan Literasi Sains: Perspektif Guru SD Di Sukabumi," *Jurnal Pendidikan Matematika dan IPA*, vol. 8, no. 1, pp. 22-23, 2017.

[4] M. Purwanti & Ristiono, "LKPD Berbasis Saintifik dengan Materi Struktur dan Fu ngsi Tumbuhan untuk Kelas VIII SMP". *Jurnal Penelitian dan Pengembangan Pendidikan,* vol. 5, no. 3, pp. 12-19, 2021

[5] Koballa & Chiapetta. *Science Instruction in the Middle and Secondary Schools.* Pearson: USA. 2010.

[6] I. W. Distrik, C. Ertikanto, A. Suyatna and W. Suana, "The Effect Of Real Model In Enhancing Metacognition Of Abstract Physics Topic," *International Journal of Research – Granthaalayah*, vol. 6, no. 6, pp. 389–395, 2018.

[7] N. Demirci, "Students Conceptual Knoledge about Electrocity and Magnetsm and its Implications: An Example of Turkish University," *Science Education International*,vol. 17, no. 1, pp.49-64, 2006

[8] P. Luangrath, S. Pettersson and S. Benckert, "On the use of two versions of the force concept inventory to test conceptual understanding of mechanics in Lao PDR," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 7, no. 2, pp.103–114, 2011.

[9] A. Susanto, " *Teori Belajar dan Pembelajaran di Sekolah Dasar*". Jakarta. Kencana Prenadamedia Group. 2013.

[10] V. Firmansyah, F. Khoirunnisa, and F.S Silitonga," Analisis Kebutuhan Petunjuk Praktikum Berbasis Keterampilan Proses Sains Untuk Mencapai Kemampuan Merancang Eksperimen", *Jurnal Zarah*, vol. 7, no. 1, 2019.

[11] W. A. Amilia, A. Abdurrahman, A. Suyatna, I. W. Distrik, and K. Herlina, "Practicality and Effectiveness of Student' Worksheets Based on Ethno science to Improve Conceptual Understanding in Rigid Body," *Int. J. Adv. Eng. Manag. Sci.*, vol. 4, no. 5, pp. 400–407, 2018.

[12] D. Mulyasari, W. Gunarhadi, & Roemintoyo, E-LKPD based on Problem Based Learning (PBL) Approach to Measure Mathematics Literacy Ability of Elementary Students. *International Journal of Elementary Education*, vol. 6, no. 3, pp. 1-10, 2022.

[13] A. A. Anggraeni, I. W. Distrik, and U. Rosidin, "The validity and practicality of the student worksheet using STEM-based multiple representations in physics learning," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 1796, no. 1, pp. 1-8, 2021.

[14] V. Fitriani, "Analisis Kebutuhan Siswa Terhadap Panduan Praktikum Berbasis Problem Based Learning," *Journal Of Education In Mathematics, Science, And Technology,"* vol. 2, no. 1, pp. 10-15, 2019.

[15] I. Arifah, A. Maftukhin, and S.D Fatmaryant, "Pengembangan Buku Petunjuk Praktikum Berbasis Guided Inquiry untuk Mengoptimalkan Hands On Mahasiswa Semester II Program Studi Pendidikan Fisika Universitas Muhammadiyah Purworejo Tahun Akademik 2013/2014," *Jurnal Radiasi*, vol. 5, no. 1, pp. 24-28, 2014.

[16] M. Muthoharoh, I.M Kirna, and G.A Indrawati, "Penerapan Lembar Kerja Peserta Didik (LKPD) Berbasis Multimedia untuk Meningkatkan Motivasi dan Hasil Belajar Kimia," *Jurnal Pendidikan Kimia Indonesia*, vol. 1, no. 1, pp. 13-22, 2017.
[17] C. D. R Irawan, and M. Sri Yuliaritiningsih, "Pengaruh Pendekatan Saintifik (Scientific Approach) Terhadap Peningkatan Keterampilan Proses Sains Siswa," *Antolgi UPI*, Vol. 5, no. 1, pp.315 – 325, 2017.
[18] Y. Febriana, "Penerapan Pendekatan Saintifik Untuk Meningkatkan Keterampilan Proses Sains Di Kelas IV SD," *Jurnal Pendidikan Guru Sekolah Dasar*, vol. 1, no. 1, pp.142-155, 2016.
[19] R. Zahara, A. Wahyuni, and E. Mahzum, "Perbandingan Pembelajaran Metode Praktikum Berbasis Keterampilan Proses Dan Metode Praktikum Biasa Terhadap Prestasi Belajar Siswa," *Jurnal Ilmiah Mahasiswa (JIM) Pendidikan Fisika.* vol. 2, no. 1, pp. 170-174, 2017.
[20] W.R Borg and M.D Gall, .*Educational Research: an Introduction*. Boston : Perason Education Inc. Boston, 2003.
[21] T. G. Ratumanan, "Pengembangan Model Pembelajaran Interaktif dengan Setting Kooperatif (Model PISK) dan Pengaruhnya terhadap hasil Belajar Matematika siswa SLTP di Kota Ambon," *J. Matematika*, vol. 10, no. 2, pp. 1-10, 2003
[22] R. R. Hake, "Relationship of Individual Student Normalized Learning Gains in Mechanics with Gender, High-School Physics, and Pretest Scores on Mathematics and Spatial Visualization," *Physics Education Research Conference.*, vol. 8, no. 1, pp. 1-14, 2002.
[23] N. Nieveen, "*Prototyping to Reach product Quality," Kluwer Academic Publisher*, vol. 10, no. 1, pp. 125-135. 1999.
[24] R. I. Arends, *Learning to Teach.* McGraw Hill Companies: Central Connecticut State University, 2007.
[25] B. Joyce and M. Weil, *Model of Teaching.* New Delhi: Prentice-Hall of India, 2003.
[26] I. W. Distrik, W. Setiawan, & C. Ertikanto, "Building physics concept understanding and problem-solving ability in online learning through the concept attainment model," *Jurnal ilmiah pendidikan fisika Al-Biruni*, vol. 1, no. 1, pp. 141–150, 2022.
[27] S. Widodo, "Pengembangan Lembar Kegiatan Peserta Didik (LKPD) berbasis Pendekatan Saintifik untuk Meningkatkan Keterampilan Penyelesaian Masalah Lingkungan Sekitar Peserta Didik di Sekolah Dasar," *J. Pendidikan Ilmu Sosial*, vol. 26, no. 2, pp. 189-204, 2017.
[28] Y. Suryani, I. W. Distrik, and A. Suyatna, " The Practicality And Effectiveness Of Student Worksheet Based Multiple Representation To Improve Conceptual Understanding And Students' Problem-Solving Ability Of Physics," *International Journal of Research*, vol. 6, no. 4, pp.166-173, 2018.
[29] Wulantri, I. W. Distrik, A. Suyatna, and U. Rosidin, " Effectiveness of Creative-Inquiry-Based Student Worksheet in Improving Physics Self-Efficacy and Problem Solving of Senior High School Students," *Journal of Physics: Conference Series*, vol. 1467, no. 1, pp. 1-6, 2020.
[30] C. Citra, I. W. Distrik, and K. Herlina, "Representations Based Teaching Material to Improve Student's Self-Efficacy and Ability of Physics Problem Solving", *Journal of Physics: Conf. Series*, vol. 1467, no. 012029, pp. 1-8, 2019.
[31] H. Yanti, I. W. Distrik, and I. Khasyyatillah, "Profile of Senior High School Metacognitive Ability in Solving Problems of Abstraction on Physics

Material,"*Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, vol. 6, no. 2, pp. 241-246, 2017.

[32] F. Dola, "Pengembangan Lembar Kerja Peserta Didik Berorientasi Pembelajaran Discovery Learning untuk Meningkatkan Keterampilan Berpikir Kritis Siswa," *Jurnal Genta Mulia*, vol. 11, no. 1, pp. 65-79, 2020.

[33] Y. Suryaningsih, "Pembelajaran Berbasis Praktikum sebagai Sarana Siswa untuk Berlatih Menerapkan Keterampilan Proses Sains dalam Materi Biologi," *Jurnal Bio Education*, vol. 2, no. 2, pp. 12-19, 2017.

[34] M. Sari, D. Andra, I. W. Distrik, and K.S. Aleksandervic, "Problem-Based E-Module Integrated with STEM and Assisted by LMS to Foster Creative Thinking Ability. *Indonesian Journal of Science and Mathematics Education*, vol. 5, no. 2, pp. 224–237, 2022.

[35] I. W. Distrik, U. Rosidin, and Abdurraman, "The Role of Hots-Oriented Creative Inquiry Model for Improving Self-Efficacy and Physics Problem-Solving Ability In Gender Perspectives," *International Journal of Psychosocial Rehabilitatio*n, vol. 24, no. 9, pp. 2254–2263, 2020.

[36] I. W. Distrik, Z. A. I. Supardi, B. Jatmiko, and Yuberti, "The Effects of Multiple Representations based Learning in Improving Concept Understanding and Problem Solving Ability", *IOP Conference Series: Earth and Environmental Science*, vol. 1796, no. 012044, pp. 1-10, 2021.