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Development Of Stream-Based Teaching Materials In Training Students' Process Skills Through Science Project Activities

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Abstract—Science process skills become basic skills in solving problems and making responsible decisions. These skills are very necessary for students to live in the present and future.This study aims to create and apply teaching materials based on Project Based Learning (PjBL) model STREAM-based (Science, Technology, Religion, Engineering, Art, and Mathematic) approach in order to improve students' science process skills.This research uses Research and Development (R&D) method as well as one-group pretest-posttest design. As research subjects were 3 primary schools in the city of Banjarmasin. Based on the results of this study it turns out that teaching materials developed were feasible to use, namely 89% (very feasible) so that it can improve students' science process skills with N-Gain of 0.71 (high). The results of the student response questionnaire after using the teaching materials developed were 87% (very feasible). Teaching materials developed makes students to use their thoughts, reason, and actions efficiently and effectively to achieve certain results, including creativity.

Keywords: Science Process Skills, STREAM Approach

I. INTRODUCTION

Science process skills are skills that students need to possess. This is because science process skills play an important role in the scientific investigation process needed to learn scientific concepts science (Duran et al., 2011). Developing science process skills can guide students to face the industrial revolution 4.0 which requires everyone to have 4C skills (*Critical thinking, Creative thinking, Creativity, and Collaboration*) (Ergül et al., 2011; Griffin & Care, 2015).

Science learning in elementary schools occupies a strategic position because 21st century science education is oriented towards the development of student intelligence based on the four characteristics of science learning, namely products, processes, scientific attitudes, and implementation in daily routine. These four elements cannot be separated from one another (Azizah et al., 2020; Wahyuni et al., 2017).

Based on research conducted by Rahmawati et al., (2019) information was obtained that learning science as a process, attitude, and its implementation in everyday life is not given much attention in learning. This is one of the causes of the low quality of students' scientific skills. One indicator of the low quality of student' scientific abilities can be seen from the results of a survey conducted by *the program for international student assessment* (PISA). The results of the PISA survey in 2019 showed that the scientific skills of students in Indonesia were still at a low level with a score of 396, ranking 67 out of 72 participating countries (OECD, 2019).

This shows that students' scientific literacy skills, critical thinking skills, and science process skills are still low, causing students to be unable to work on questions in the domains of C4, C5, and C6. (Desianti, et al., 2015). Based on the results of the needs analysis which carried out in 5 elementary schools in Banjarmasin showed that science learning applied in the classroom is less attractive, students are rarely given practicum in the psychomotor domain. In addition, almost 80% of students do not have varied science learning resources other than school books and student's worksheets (LKS).

Learning innovation has been carried out by several studies such as the use of model of science learning, problem-based learning, discovery and others, but it has not been able to enhance students' science process skills (Dwianto et al., 2017; Ekici & Erdem, 2020).

The result of Tseng et al., (2013) explains that learning model of PjBL integrated STEM can increase student interest in learning and help students in problem-solving. Several other studies also explained that the use of Student Worksheets (LKS) based on PjBL model integrated STEM was able to produce competent and quality graduates not only in terms of mastering concepts but also in applying them in life; improving scientific literacy skills; science process skills; and students' critical thinking skills (Bhakti et al., 2020; Capraro et al., 2013; Sulistiyowati et al., 2018).

According to Pilecki, T., & Sousa, (2013) science and art are two complementaryelements. Science provides the tools needed in the process of scientific inquiry to producing an art, while art provides creativity and the ability of science process to the development science.

Meanwhile, *religion* elements refers to the pillars of education adopted in Indonesia in order to achieve national education goals, namely *learning to know, learning to do, learning to be, learning to live together in peace,* and learning to strengthen faith, devotion and noble morality (Kemendikbud, 2013). According to Azizah et al., (2020), the addition of elements of art and religion in the approach to STEM is enable to improve students creativity, increase the activity of students' science while studying, and making learning science becomes more meaningful with the integration of religious knowledge so that students more easily to determine a solution and opinions when discussing.

Although worksheet based on the STEM approach plays an important role in improving science process skills, the impact of teaching materials based on the PjBL model integrated STREAM approach has never been disclosed. Therefore, this study aims to explore the feasibility of teaching materials based on the PjBL integrated STREAM approach, and its impact on the science process abilities of elementary school students.

II. METHODS

This research is a development research aiming to produce valid and effective product to improve students' science process skills. The product developed in this study are thematic teaching materials based on the PjBL model using STREAM-based approach for grade V elementary school students on the theme " Environment is our Buddy".

Research and development model in this study adopts the Borg & Gall model which includes 10 steps, namely: (1) research and information gathering, (2) planning, (3) developing the initial form of the product, (4) initial field trials, (5) major product revisions, (6) major field tests, (7) operational product revisions, (8) operational field testing, (9) final product revisions, (10) socialization and implementation (Borg & Gall, 1983). Borg & Gall's development model in this study was carried out until step 6.

The first step of research is research and data collection. The activities carried out are literature studies, preliminary studies, and needs analysis. Literature study is carried out by studying theories about learning materials, the realm of science, science process skill and the other supporting theories. A preliminary study was conducted in 5 elementary schools in Banjarmasin to determine the problems and products needed in the field. The second stage is planning, which is the researcher determines product components, product objectives, and product's target users.

Furthermore, in the third stage, the activity is carried out by compiling a validation instrument for teaching materials. The validators who assessed thematic teaching materials based on PjBL model using STREAM-based approach are 4 people, consisting of 2 material experts, 1 learning expert, and 1 science teacher. In stage 4, namely the initial field trial (limited), attempted to determine the effectiveness of products based teaching materials thematic integrated PjBL model using STREAM-based approach to improve students' science process skills.

Limited trials were conducted in class. The results of this limited test are used to improve the product. The fifth stage is the revision of the main product, which is carried out by improving the product based on the results of limited trials. After the teaching material product was revised, it was continued in the sixth stage, namely the main field test. On this stage, teaching materials have been developed and then tested on the learning process in the classroom. This stage is carried out in 3 elementary schools in Banjarmasin.

The research was conducted on March 2020 – May 2020. The subjects tested were the fifth grade students of SDIT Ukhuwah Banjarmasin, SD Karang Mekar 5 and SD Muhammadiyah 8. The number of students was 80 with details: (1) limited scale trial test by 28 students from SDIT Ukhuwah Banjarmasin; (2) wide scale trial test by 80 students from SDIT Ukhuwah, SD Muhammadiyah 8 and SDN Karang Mekar 5 Banjarmasin as the experimental class.

The data collection techniques used in this study were nontest observation of science process skills, assessment of teaching material, and student response questionnaires. The test was carried out using a data collection instrument in the form of a non-test grid for science process skills. This technique is used to measure students' science process skills. The assessment of teaching material and questionnaire is used for the validation sheet of teaching materials and the student response to the application of teaching materials based on PjBL model using STREAM-based approach.

The data validation results from subject matter experts, expert teaching and classroom teachers, as well as the students' responses to find out the average percentage by using the following formula (Damayanti et al., 2018).

$$x_i = \frac{\sum S}{S_{max}} x\ 100\%$$

Keterangan:

x_i =Feasibility value
$\sum S$ =Total score
S_{max} = maximum score

After that, the percentage results obtained are interpreted in the feasibility criteria (Asyhari & Silvia, 2016) in Table 1.

Table 1. Criteria of Product Feasibility

Skor (%)	Kriteria
$\mathbf{81 < score \leq 100}$	Very feasibility

Skor (%)	Kriteria
$61 < Xi \leq 80$	feasibility
$41 < Xi \leq 60$	Decent
$21 < Xi \leq 40$	Less feasible
$0 < Xi \leq 20$	Very inappropriate

The measurement of science process skills was carried out with the character of the students using a Likert scale. The non-test scores of science process skills that have been obtained by students are then calculated and interpreted by calculating the N-gain. The formula used to calculate the increase in science process skill is as follows.

$$N - Gain = \frac{S_{post} - S_{pre}}{SMI - S_{pre}}$$

Notes:
S_{post} = Pretest Score
S_{pre} = Posttest Score
SMI = maximum score obtained

The high or low N-Gain value is determined based on the criteria which can be seen in Table 2

Table 2. N-Gain Value Criteria

N-gain value	Criteria
N – gain ≥ 0.70	High
0.30 ≤ N – gain < 0.70	Moderate
N – gain < 0.30	Low

Students' science process skills was said to be increased if the normalized gain was classified as a moderate criterion or 0.30 ≤ N-gain <0.70.

III. RESULTS AND DISCUSSION

Needs analysis is carried out at schools through interviews with teachers and also giving questionnaires to both students and teachers. The results of the interview with the teacher explained that teaching materials were needed in science learning to be able to develop students' science process skills. Teaching materials should contain material and the lawyer implementation of material that is based on practical work and projects related to everyday life.

The results of the teaching materials validation carried out by researchers were given to 2 material experts, 1 learning expert, and 1 science teacher. There are three aspects of teaching materials validation criteria. The first aspect is the feasibility of the contents of the 4 indicators related to the learning material, and the suitability of needs. The second aspect is that language has 4 indicators, namely readability, clarity of information, suitability of language in the level of student development, effective and efficient use of language. The third aspect is that the presentation has 4 indicators related to the appearance of teaching materials using font size, illustrations, images, layouts, and designs. The validation results can be seen in Table 3.

Table 3. Results of the validation of teaching materials integrated PjBL model using STREAM-based approach

Instrument Aspect	Validator				Average	Criteria
	V1	V2	V3	V4		
Content feasibility	85%	95%	80%	90%	88%	Very feasibility
Language	80%	95%	85%	95%	89%	Very feasibility
Presentation	90%	90%	90%	95%	91%	Very feasibility
Average	85%	93%	85%	93%	89%	Very feasibility

Based on the results of data analysis, the assessment sheet for the expert validators and science teachers for Elementary Schools, the designs that have been developed by the researcher are validated by the validators and get input related to column layout, the suitability of image illustrations with teaching material, improvement of concept maps, and effectiveness and efficiency use of language. Researchers made revision to the development of teaching materials so that limited scale product trials could be carried out.

The teaching materials developed in this study are based on PjBL using STREAM-based approach which includes project based activities carried out by students in groups to produce creative products. In the implementation of learning it is associated with the surah of the Koran and the hadiths so that it makes learning more meaningful. This is supported by Long & Davis (2017) which explains that the STEAM approach in learning provides opportunities for students to explore science learning through project activities related to daily basis.

The initial appearance of teaching materials is in the form of a full color front cover design consisting of the title of the book theme, class, author and a summary related with the PjBL integrated model with the STREAM approach on the back cover. The display of teaching materials after the cover, namely the learning concept map on the development of teaching materials. The development of the initial appearance of teaching materials can be seen in Figure 1.

(a) (b)

Figure 1. Front and back cover view (a), learning concept map (b)

The development of teaching materials based on the PjBL model integrated with STREAM approach begins with a step model of PjBL is the determination of the fundamental questions followed by aspects of science on the STREAM approach. The steps for determining the basic questions can be seen in Figure 2.

(a) (b)

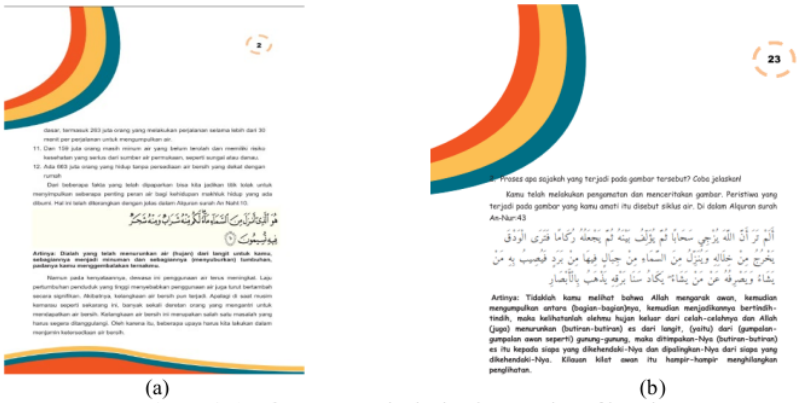
Figure 2. Discussion material as aspect of *science* (a), and the stage of determining fundamental question (b)

Furthermore, the development of teaching materials PjBL using STREAM-based approach on aspects of technology that lies in the use of laptops and the Internet to carry out the project. In this aspect, there are PjBL steps, namely preparing a project plan. Based on the research conducted by Gale et al., (2020) the technology aspect of the STEAM approach can increase student's creativity and understanding of a problem. The technology aspects can be seen in Figure 3.

(a) (b)

Figure 3. *technology* aspects in the implementation of learning

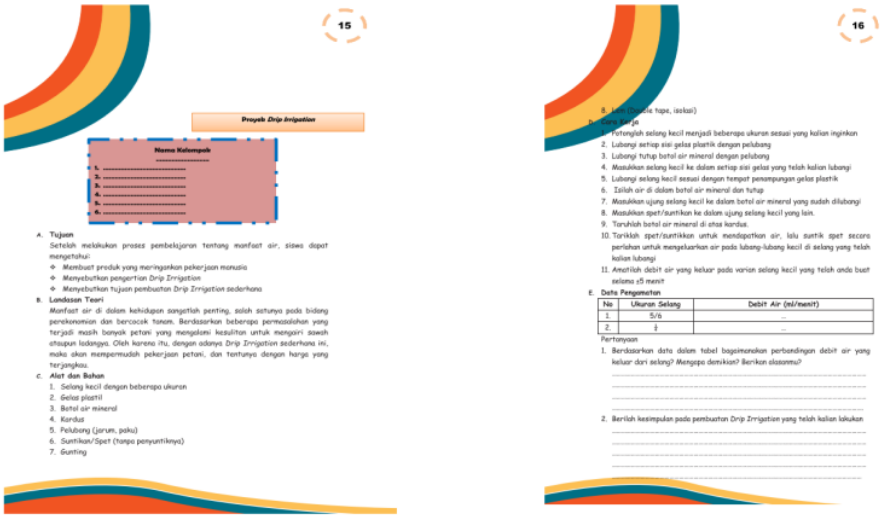
In the religion aspect, the steps taken by PjBL are monitoring students' work and the progress of their projects and during self-evaluation based on their experiences working on projects. In this aspect, science learning is associated with religious knowledge. Based on several studies, it is explained that the integration of religious knowledge into learning can improve students' mastery of concepts and learning activities (Azizah et al., 2020; Khoiri et al., 2017). The *religion* aspect on teaching material can be seen in Figure 4.



(a) (b)

Figure 4. A *religion* aspect in the implementation of learning

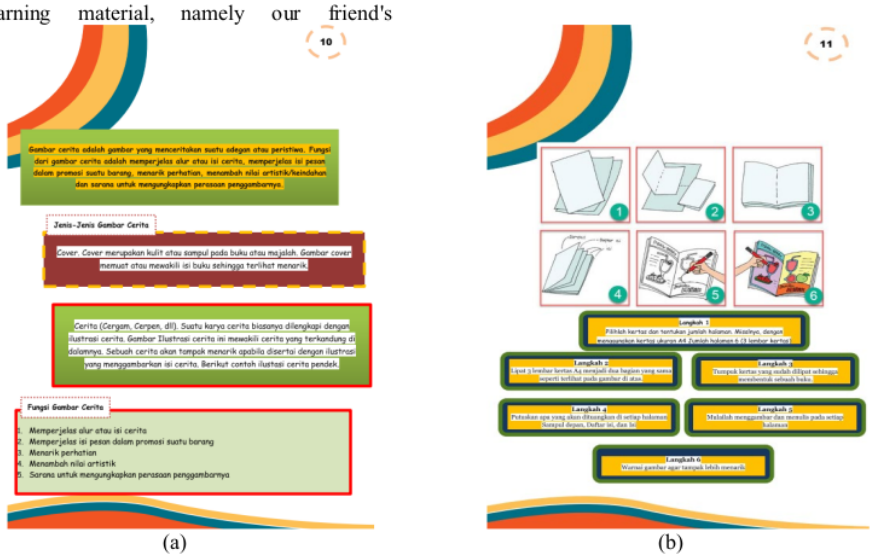
Engineering aspects cannot be separated from Mathematic aspects. Engineering and mathematics aspect in teaching materials, are namely the activities of students in groups to design a creative product. In this engineering aspect, the teacher steps in to monitor students and project's progress. Meanwhile, on the mathematics aspect, students calculate the amount of water discharge resulting from the creative products they make. A mathematical aspect is adjusted to mathematics material in Class V Elementary School Semester II. At these two stages, the teacher acts as a student facilitator in the project creation process. During the engineering process, students design and create their creative products with group teams. After these two stages are completed, next step of PjBL model is to evaluate the results. Based on several studies, it is explained that through designing a product, students' enthusiasm for learning increases so that learning activities become active and the integration of mathematics learning becomes more interesting and meaningful (Costantino, 2018; Engelman et al., 2017; Li & Schoenfeld, 2019). The results of the development of engineering and mathematical aspects can be seen in Figure 5.



(a) (b)

Figure 5. *Engineering* aspects (a), and *mathematic* aspects (b)

In the art aspect, the steps for PjBL are when monitoring students and project progress, as well as when assessing results. In this aspect, students in the group work on picture stories related to learning material, namely our friend's environment. This art activity lasts for 4 lessons. Each group is given the freedom to determine the theme of the story. The results of the development of the art aspect can be seen in Figure 6.



(a) (b)

Figure 6. The *art* aspect of learning

Based on the research conducted by (Park et al., 2016) it was explained that implementing the STEAM approach can encourage student interest in learning, improve students ' thinking, and increase students' understanding of learning material. This can be seen from the responses of students in 3 schools in Banjarmasin, totaling 80 students, to the implementation of teaching materials using PjBL using STREAM-based approach on theme 8 "Our Friends' Environment" in Table 4.

In the main test field trials (large scale) learning as much as 4 meetings is conducted. The implementation of PjBL model using STREAM-based approach is carried out by making 4 creative product designs, therefore; drip irrigation, water cycle, water quality test, environmental conservation and story picture booklets related to religious aspects.

Table 4. Students Response Values

Aspect	%	Criteria
Learning Model	92%	Very feasibility
The PjBL integrated knowledge model The STREAM Approach	82%	Very feasibility
The use of Textbook	88%	Very feasibility
Average	87%	Very feasibility

During the learning process, the teacher makes assessments related to science process skills.

The science process skills non-test sheet was used to find out how the development of students' science process skills from the beginning of using teaching materials based on PjBL model using STREAM-based approach and after using teaching materials based on PjBL model using STREAM-based approach.

Indicators sheet non-test science process skills used in this study refers to Harlen, (1999) and American Association for the Advancement of & Science (AAAS) (1967) in which the researcher concludes 6 indicators science process skills are observation, classification, prediction, experimentation, interpretation, and communication. The indicators of science process skills in this study can be seen in Table 5.

Table 5. The Non-test assessment Indicator of Science Process Skills

Indicator	Criteria
Observation	Requires a little assistance Preparing the required equipment for the project Using the appropriate tools and materials
Classification	Finding some similarities or differences
Prediction	Predicting based on the relationship between sufficient data or information, tendency or pattern.
Experimentation	Being creative in using technology so that ended up in producing various products Seeking to solve problems by applying relevant skills or knowledge
Interpretation	Drawing conclusions based on sufficient data / information which is valid and reliable
Communication	Students convey project results orally and in written forms

The assessment result of students' science process skills using development of teaching materials based on PjBL model using STREAM-based approach at the beginning and the end of the activities can be seen on Table 6.

Based on Table 6, the average N-gain of students' science process skills using teaching materials based on PjBL model using STREAM-based approach is in the high criteria of improvement. Improvement to students' science process skills can be seen in each of the science process skills indicators presented in Figure 7.

Table 6. Results of Increasing Students' Science Process Skills

Class	Initial Average	Final Average	N-Gain Average	Criteria
Exsp	44	88	0,71	High

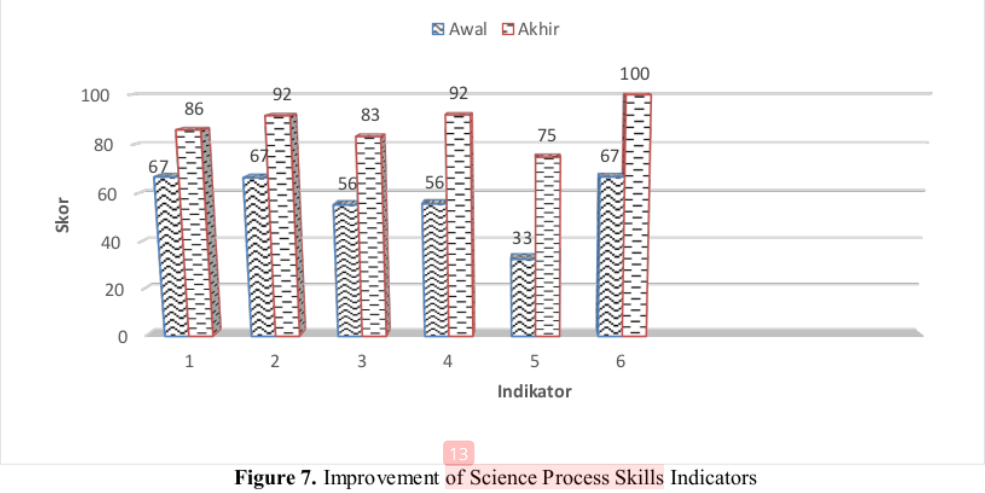


Figure 7. Improvement of Science Process Skills Indicators

Based on Figure 7, it can be concluded that the whole indicators of science process skills have increased significantly. The notable improvements were in the experiment, interpretation, and communication indicators. When using teaching materials based on the PjBL model using STREAM-based approach, students get information about scientific knowledge by being actively involved in the discussions.

Learning begins with the teacher reading the surah in the Koran related to the subject matter, and then the teacher associates it with a science problem in the context of everyday life. Furthermore, students are divided into groups to discuss the solutions related to the problems that the teacher presents. During the discussion process, students are given laptops as learning support to obtain additional information they need to make predictions. The solution they create will be continued by making a project design. The implementation of the design of this project takes a good look in the engineering aspects, where at this stage students plan and design using the engineering design process (EDP) so that they are able to make them produce innovative creative products. Making products based on the stages of the EDP process enables students to be more appropriate to interpret a conclusion from the project that has been worked on. This is supported by the research of Sulistiyowati et al., (2018) which explains that the STEM approach makes students actively involved in the experimental process, collecting data, processing data, and drawing conclusions.

At first, students' science process skills were not optimal. This is because students are not used to carrying out the stages of the science process in learning. After the application of teaching materials based on the PjBL model using STREAM-based approach, the average science process skills of the students in facing were in a high category. The use of teaching materials based on the STREAM integrated PjBL model enables students to search for and obtain data with systematic and logical scientific steps so that it has an optimal impact on the increasing in indicators of experiment, interpretation, and communication.

This is supported by the research Zeitoun & Hajo (2015) explain that science process skills provide a foundation for learning more complex skills. Based on several studies, it is also explained that the application of teaching materials for the PjBL STEM model encourages students to be actively involved in learning so as to improve science process skills; scientific literacy; problem solving skills; and improve students' scientific attitudes (Bhakti et al., 2020; Ergül et al., 2011; Lestari et al., 2018; Setiawaty et al., 2018; Wahyuni et al., 2017).

The use of the STEM approach in learning makes students discover an innovation or design new things so that they have good scientific literacy skills to face the era of globalization and demands in the 21st century (Sulistiyowati *et al*., 2018).

The addition of religion element to teaching materials based on PjBL model using STREAM-based approach begins with students identifying contextual problem associated with religious aspects so that students may connect knowledge and the application of religious aspects in everyday life, so that learning becomes meaningful. This is supported by several studies which explain that adding religious aspects to learning can improve student learning outcomes and foster Islamic characters (Khoiri *et al.*, 2017; Yusnita *et al*., 2016).

Meanwhile, the addition of art elements to teaching materials based on PjBL model using STREAM-based approach is able to make interactions between students in the group active. Simple project activities on teaching materials help students understand science concepts by finding their own learning experiences. This makes students enthusiastic in exploring the capacity to think for determining a proper solution to solve problems during the project, so this impact on improving students' science process skills.

This is in line with several studies which explain that the application of the STEAM approach can increase creativity, problem-solving abilities, and make scientific conclusions that make them enjoy the learning process (Allina, 2018; Perignat & Katz-Buonincontro, 2018).

IV. CONCLUSION

Based on the results of the research and discussion, it can be concluded that teaching materials based on the PjBL model using STREAM-based approach are very feasible to use with the validation results of 89%, and the student response score of 87% with a very feasible category. Teaching materials based on the STREAM integrated PjBL model are also effective for improving science process skills of elementary school students with an N-Gain of 0.71 with a high category. Indicators of science process skills that have an optimal increase are indicators of experiment, interpretation, and communication.

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