JIPVA (JURNAL PENDIDIKAN IPA VETERAN)
Volume 7 - Nomor 2, 2023
Available at http://e-journal.ivet.ac.id/index.php/jipva
ISSN : 2598-5876 (print), 2598-0904 (online)

Development of STEAM Learning Module to Improve Students' Science Process Skills

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Artikel info
Received : 6 Oct 2023
Revised : 23 Nov 2023
Accepted : 30 Nov 2023

Keywords:
learning module;
science process skill;
STEAM

ABSTRACT

The learning modules used are still limited to answering questions, there are not many that connect students' knowledge with more meaningful learning, close to problems that are often encountered every day. This research aims to produce valid STEAM learning modules in elementary schools. Validation was carried out by two lecturers and three teachers where they validated the format and graphics, content and language. The research results showed that the format and graphics aspect got 14.8 with a percentage of 92.5%, the content aspect got 17.8 with a percentage of 92% and the language aspect got 14 with a percentage of 90%. In addition, with the results of the student's readability test, a score of 90.7% was obtained. Therefore, STEAM learning modules are suitable for use in elementary schools because they have good validity and increases science process skill.

https://doi.org/10.31331/jipva.v7i2.2932

How to Cite: Dewi, N. D.L., Agustiningsih, A. & Arif, M. B. S. (2023). Development of STEAM Learning Module to Improve Students' Science Process Skills. *JIPVA (Jurnal Pendidikan IPA Veteran), 7(2), 99-110.* doi: https://doi.org/10.31331/jipva.v7i2.2932

INTRODUCTION

Education cannot be separated from the learning process. The learning that teachers need to carry out must be oriented towards 21st-century learning. One learning approach that can adapt to the characteristics of 21st-century learning is the Science, Technology, Engineering, Art, and Math approach abbreviated as STEAM. STEAM is an approach that combines science, technology, engineering, arts, and mathematics with an emphasis on learning to solve real-life problems. STEAM learning shows students how the concepts and principles of science, technology, engineering, and mathematics are used in an integrated manner. The STEAM learning concept can start with phenomena or problems that exist in daily activities.

STEAM learning refers to how to gain knowledge to identify problems and gain new knowledge. Education for the twenty-first century demands skills in science, technology, engineering, and mathematics (STEM) to deal with challenging complex situations, and these capabilities need to be developed as early as primary school (National Research Council, 2015). Whereas the connections between math, science, and technology are common, a more up to date acronym has started to crop up among discussions called STEAM. STEAM employments the acronym STEM and includes an “A” to represent art inside the ponder of STEM. Art provides more practice with habits of mind such as creativity, open-ended investigation, and exploration that is inherent when someone does art within the STEM experience (Bequette & Bequette, 2015; Boakes, 2020). 21st-century learning is student-centered, students are given the opportunity to work together, learning material is related to problems encountered in everyday life, and educates students to become responsible individuals. Learning must be designed in accordance with the 4C skills which include, 1) critical thinking skills (critical thinking skills), 2) creative and innovative thinking skills (creative and innovative thinking skills), 3) communication skills (communication skills), and 4) collaboration skills (collaboration skills) (Rosnaeni, 2021)

Currently, Indonesia is experiencing curriculum changes and the Independent Curriculum is becoming an innovation in education in Indonesia. Independent Curriculum provides freedom in planning and implementing the education process so that learning loss found during the pandemic is expected to disappear or improve. An independent curriculum is an education system based on freedom of thought and learning for teachers and students (Prahani et al., 2020). It is felt that this opportunity for freedom of innovation can be used as a way to introduce STEAM in Indonesian education, especially in primary schools. The Indonesian government, Ministry of Education and Culture supports a student-centered learning process by providing one thing to strengthen the Pancasila Student Profile (Nurjolis & Andik, 2023). This means the STEAM approach is believed to be one way that is in line with and can be implemented with the Independent Curriculum. STEAM as a learning approach can provide solutions to the obstacles and challenges that arise in implementing an independent curriculum (Fakhruddin et al., 2022). STEAM can encourage students and teachers to develop problem-solving skills, higher-order thinking, care for the environment, independence, and responsibility (Fakhrudin et al., 2021).

STEAM education should begin in primary schools and aim to prepare young people for active participation in their future (Kurup et al., 2019). STEAM practices promote students’ pursuit of new ideas, concepts, or processes that meet a need in this 21st century (Siregar et al., 2020).Prior research has shown the integration of STEAM has a positive impact on elementary, middle, and high school student achievement. For example, Kusumastuti et al (2019) state that students who studied with the integration of STEM education improved the quality of answering questions and provided a better explanation than the students who studied with a common project-based study. Zainil et al. (2023) research says that students with high and low higher-order thinking skills who are taught STEM have a connection to 21st-century skills. The same research carried out by Murdiasih & Wulandari (2022) that state STEM approach is quite effective in increasing junior high school students' creative thinking skills.

There is still not much development of STEAM modules, especially in primary schools whereas Kurup et al (2019) states that STEM education needs to begin in primary schools. According to the problems above, it is very interesting to research the use of STEM in primary school. STEM-based education will make human resources that can reason and think critically, logically, and systematically (Norlaili et al., 2022). Johnson et al (2021) clarified five characteristics that distinguish integrated STEAM instruction from other teacher pedagogy: (a) the content and practices of one or more anchor science and mathematics disciplines define some of the primary learning goals; (b) the integrator is the engineering practices and engineering design of technologies as the context; (c) the engineering design or engineering practices related to relevant technologies requires the use of scientific and mathematical concepts through. STEAM approach can improve science process student skills (Syukri et al., 2021,Lumbantobing et al., 2022). Students find that they can apply what they learn to their lives and that learning outcomes are more meaningful through their own experiences when contextual materials are used. The application of STEM learning provides a simultaneous influence on the students' science process skills and science attitudes toward chemistry education (Setiawaty et al., 2018). STEAM in P5 can be implemented at project stages designed by implementing STEAM implementation types, namely inter-discipline STEAM, several STEAM disciplines, or all STEAM disciplines (Nurmawanti et al., 2023). STEAM's approach is the integration of science with technology in a thoughtful way to techniques and arts, in which all of these disciplines contain elements of mathematics as the parent of science (Ni et al., 2018). Thus, in this study, the STEAM learning module is expected to improve primary school students's science process skills. (Lock, 1990) practical skills assessment can be seen from observing, manipulating, interpreting, planning, reporting, and self-reliance. Furthermore, Dewi & Prasetyo (2016) state that practical skills have categories including procedural skills and manipulative skills, observation skills, drawing skills, and reporting and interpreting skills.

The material chosen in this STEAM learning module is class V Primary School Food Chain and its problems. This selection is because the subject matter closely relates to students' daily lives. However, it is rarely studied to implement the STEAM in primary school. I conducted "Validity of STEAM Learning Module to Improve Students' Science Process Skills" a study to answer it.

METHOD

Type of Research

ADDIE development model is used in this research. It consists of five stages. These are Analysis, Design, Development, Implementation, and Evaluation, which is limited to three stages: analysis, design, and development for validity.

Research Procedure

An Analysis stage starts with analyzing the needs of the learning module and curriculum in school. The results obtained are used to develop a STEAM learning module in material the food chain and its problems. The next stage is Design, in this stage, the researcher formulates and develops learning objectives, content knowledge, and product content. Then, they will be obtained by emphasizing the STEAM in the food chain and its problems to student's science process skills. Then, for the Development stage, research does the realization activity of the product. First, research collecting the materials, making products, testing the validity of the learning module by experts, and doing revisions. A validity test is used to evaluate the functionality of a product that students can use during their learning process. The research procedure is shown in Figure 1 below.

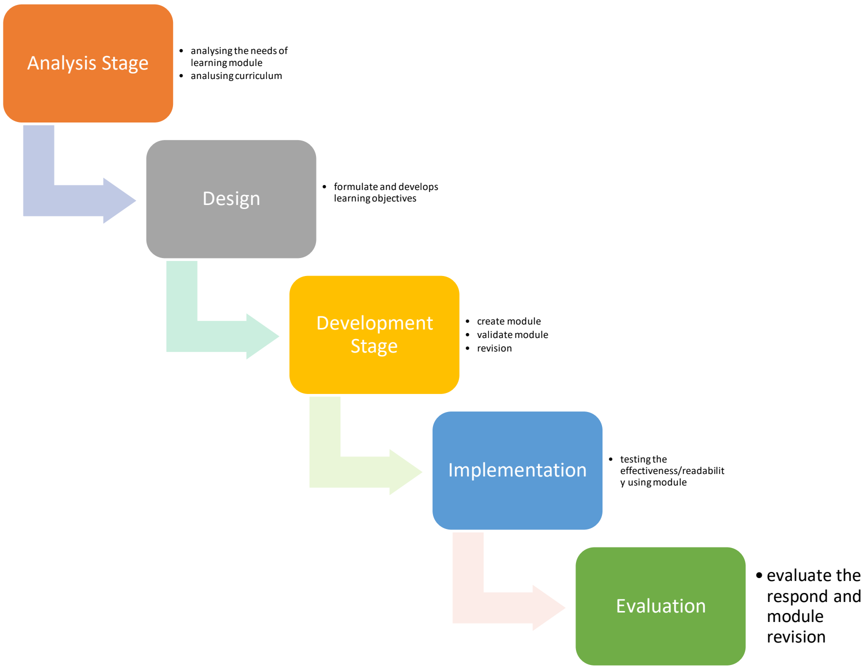

Figure 1. Research Procedure Reseacrh

Data, Instrument, Data Collection, and Data Analysis Technic

Data collection includes validation forms. Two experts and 3 practitioner were used to validate the STEAM learning module. The validity assessment consists of four parts. There is the content aspect, the presentation aspect, the language aspect, and the visual aspect. Then, the result of validity by experts and practitioners was carried out by determining the score by a Likert scale. After that, the researcher calculated the average of assessments in each aspect and converted the average score into qualitative shown in Table 1.

Table 1. Product category criteria interval conversion

Score Interval	Category
$Xi + 1.8\ Sbi < X$	Very good
$Xi + 0.6\ Sbi < X \leq Xi + 1.8\ Sbi$	Good
$Xi - 0.6\ Sbi < X \leq Xi + 0.6\ Sbi$	Fair
$Xi - 1.8\ Sbi < X \leq Xi - 0.6\ Sbi$	Poor
$X \leq Xi - 1.8\ Sbi$	Very Poor

(Monita & Ikhsan, 2020)

To calculate the percentage of the answer use the formula shown in Equation 1.

$P = \frac{\Sigma x}{n}$ x 100%

Information:
P = percentage
x = the sum of each validator's scores on each aspect of the assessment
n = maximum score of assessment aspects

Data analysis used for learning module validity is based on validity criteria in Table 2 below.

Table 2. Categories of Validity and Practical Category of Learning Module

No	Score Interval	Validity Category
1	0.81 – 1.00	Very valid
2	0.61 – 0.80	Valid
3	0.31 – 0.60	Fair
4	0.21 – 0.30	Invalid
5	0.00 – 0.20	Very invalid

(Gregory, 2007)

The validity of the learning module is declared valid in terms of material validity if the validity coefficient value obtains a minimum score of 0.61 with good qualifications.

Table 3. Score criteria for qualifying validity tests and practicality tests

No	Score Interval	Qualifying validity	Qualifying practicality
1	80 – 100	Very valid	Very practical
2	66 – 79	Valid	Practical
3	56 – 65	Fair	Quite practical
4	40 – 55	Invalid	Less practical
5	0 – 39	Very invalid	Not practical

Arikunto dalam (Millah et al., 2012)

Overall feasibility (readability) percentage calculated using the formula:

$$P\ \% = \frac{total\ score\ resulting\ from\ data\ collection}{criretia\ score} \text{ x } 100\ \%$$

Criteria score = Highest score for each aspect x Number of aspects x Number Validator

Data from the validation of student readability is analysed using qualitative descriptive methods. The categories for student response is shown in Table 4.

Table 4. Students response category criteria

Ranges of Values	Category
85% - 100%	Very good
$69\% - 84\%$	Good
53% - 83%	Fair
$37\% - 52\%$	Poor
$< 36\%$	Very Poor

Then, the results of the assessment of the learning module if it obtains a minimum average score of 66 with valid, practical, and good qualifications by students readability with the minimum of 69% so it can be stated the learning module obtained is suitable for use and valid.

RESULTS AND DISCUSSION

This research produced a STEAM learning module to improve students' science process skills in primary school. This learning module was validated by two validators, three practitioners, and through a readability test process by students. This process is based on the stages of ADDIE development model which is limited to three stages.

Analysis stage. For initial, the researcher does need analysis and curriculum analysis. In-need analysis, it carried out by using journal analysing, proceeding, and thesis related to STEAM in primary school and science process skills in primary school. For curriculum analysis, it used the Independent Curriculum. In addition, the teaching module or teaching materials used in learning are only oriented to practice questions and some content material. Learning module commonly used has not linked to problems that exist in daily life. Curriculum analysis is carried out to adjust competency and formulate the learning objective.

Design stage. This state is beginning to map the science content knowledge in primary school. After that, a concept map is formulated to describe the sub-content that will be shown in the STEAM learning module. STEAM learning module is designed contextually with images dan illustrations of problems in daily life. Then, in this stage also designing material, problem-based questions and activity, integrate subject and assessment. Design material is presented in detail and arranged systematically. It makes it easier to understand the material for students. STEAM learning module load information detail such as “Faktanya” which contain problem in daily life, “Ayo mencoba” which contains activities related material, and “Refleksi” contain direction to students reflect on attitude and behaviour regarding problems surrounding environment and question students must do.

Development stage. This stage obtained STEAM learning module that has been compiled and are ready to be validated. The learning module developed consist of initial part, content part, and a final part. In the initial section, the process is include design cover, table of content, learning objectives and mapping of concepts. In the content section, it start with problems related in daily life such as Butterfly and Its Habitat for example. With this theme, researcher writes some problems relate to themes and link to STEAM aspect. Final section, it is include a glossary, a bibliography and a back cover. The feasibility of STEAM learning module is carried out by two expert and three practitioners. The expert validator consists of science lecture and Bahasa lecturer. Average score of each aspect of the assessment by expert and practitioners is shown in Table 5 below.

Table 5. Validation Results

Aspect	Score	Score Interval	Category
Format and Graphic	14,8	$14 < x \leq 17$	Good
Content	17,8	$X > 17$	Very good
Language	14	$14 < x \leq 17$	Good

The percentage for the results of the validation in each aspect is shown in Figure 2 below.

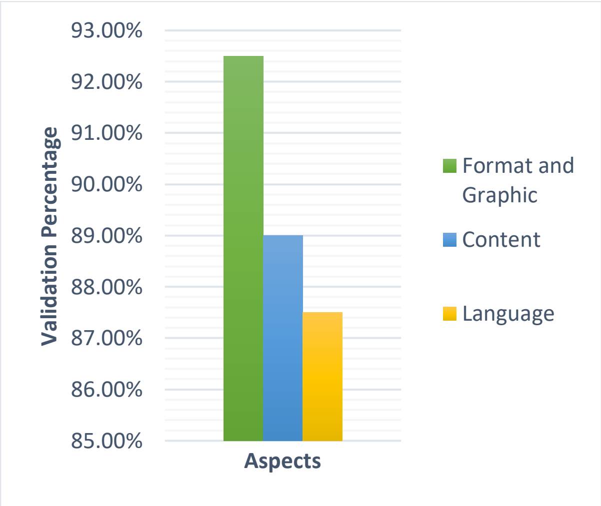

Figure 2. Percentage of validity test result in every aspect

Then, analysis results from expert and practitioners that has been developed is shown in Table 6.

Tabel 6. Expert and practitioner validation result

No	Validators	Percentage	Criteria
1	Validators 1	96%	Very valid
2	Validators 2	86%	Very valid
3	Validators 3	86%	Very valid
4	Validators 4	92%	Very valid
5	Validators 5	88%	Very valid
Average		89,6%	Very valid

The average percentage of validity by validators is 89,6%. The aspects of validity product consist of three aspect: the format and graphic, content and language. The format and graphic aspects aims to assess design, appearance, and component of learning module. The content aspects is assess the subject matter, integration and quality of content. The language aspects aim to provide an assessment the use of language and readability of STEAM learning module. The score for the format and graphic is 14,8 with a percentage result of 92.5. The score for the contents 17,8 with a percentage result of 92. The score for the language is 14 with a percentage result of 90. The score interval in each aspect of the assessment of teaching materials can be seen in table 1. Learning module validated is testing by students as readability test in primary school grade six. The result is in each aspect is in very good category with a percentage of 90.7 with details 90%, 92% and 90%.

Based on the criteria then the learning modules are in a very valid and very practical category and suitable to be used in school. In addition, the result of student's response (readability test) can be seen in Table 7 below.

Table 7. Students response in each aspects

Validators	Percentage	Criteria
Format and Graphic	90%	Very good
Content	92%	Very good
Language	90%	Very good
Average	90,7%	Very good

Based on Table 5, Table 6, and Figure 1, it showed that the STEAM learning module developed contain three aspects namely format and graphic, content, and language. The validated STEAM learning module is shown in Figure 2.

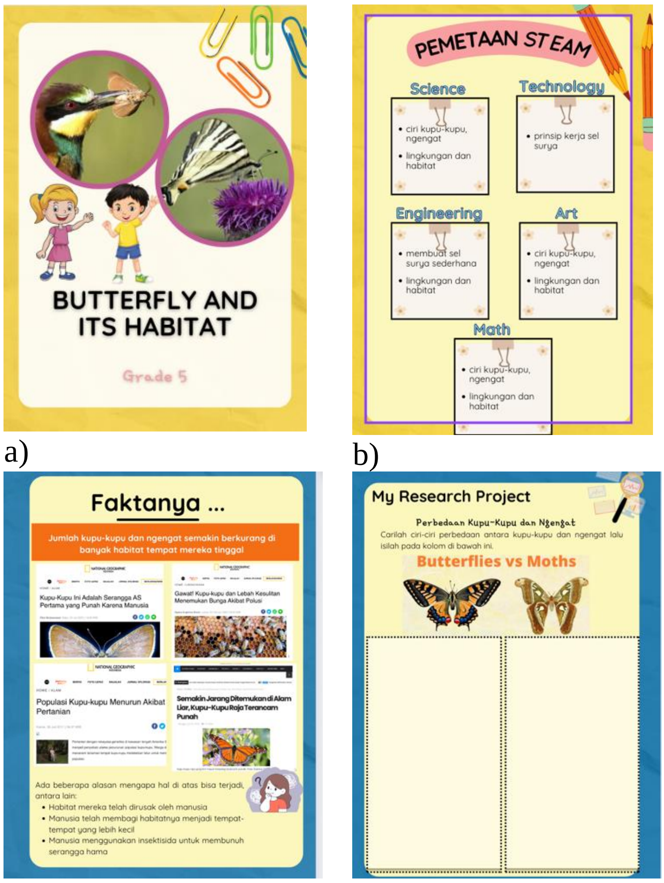

Figure 3. a) Cover b) STEAM Mapping c) Material Description

Module preparation was done by determined the materials, the competence and determining the format and design of the module by using Canva, A4 module size, yellow blue domination of font type Quicksand 12. The next step is make an outline of the module such as cover, cover page, preface, table of contents, STEAM mapping, learning objective, material description, activity, final section, summary, glossary and bibliography. The module based on STEAM can be seen in Figure 3. Whether or not a module to be used is obtained from expert validation results before being tested. Validation in this research consist of practitioners, experts, and readability by students, which can be seen in Table 6 and Table 7.

Expert validation was done to find out eligibility and weekness in product development. Also, validation is an assessment and suggestions for improvements needed (Sofia et al., 2020). Content validation by experts is carried out to look for weaknesses and suitability of the module. Aspects assessed include language, graphics and content. The user validation were three teachers. Based on Table 5 and Table 6, it is known that STEAM module is suitable for use in learning activities. The application of the STEAM approach can improve students' mastery of concepts (Arce et al., 2022; Thuneberg et al., 2018; van Broekhoven et al., 2020). To evaluate the validity is based on: the product developed is based on strong theoretical reasons and the product developed has internal consistency (Nieveen, 1999). Thus, teachers who judge that the learning product is right and can be appropriately used by its users, namely teachers and students, are stated by a development product’s practicality (Hasmawaty et al., 2020). It is like the data showed in Figure 2 and Table 6, the average percentage of validity by validators is 89,6%. It means that the content aspects is assess the subject matter, integration and quality of content. The language aspects aim to provide an assessment the use of language and readability of STEAM learning module. The score for the format and graphic is 14,8 with a percentage result of 92.5. The score for the contents 17,8 with a percentage result of 92. The score for the language is 14 with a percentage result of 90. This result showed that the STEAM module are easy to read, the language used in the module is in accordance with the rules of Indonesian language that is correct and good, and good in terms of readability and clarity of information. The score interval in each aspect of the assessment of teaching materials can be seen in table 1. Learning module validated is testing by students as readability test in primary school grade six. The result is in each aspect is in very good category with a percentage of 90.7 with details 90%, 92% and 90%. So, valid product which is the STEAM module then can be used in development test. For implementation, the module is used in some students to know the readability. In addition, the result of student's response (readability test) can be seen in Table 7. That shows the criteria for language, content and graphics have scores above 90 in the very good category. This very good category means the module is ready to be used for the next stage.

Materials in module, learning objective and activity are clearly written. The concepts in the module are clearly explained through problems that are often found in everyday life. Some materials explore new knowledge that is successfully linked to the knowledge that students already have. Rate constructs validation on aspects of obtaining an average value of 89,6% with a very valid category. This results show that the module developed meets the criteria of validity development of teaching material and be used to help student understand the learning material ecosystem and their habitats. Students are able to construct their own learning and go full STEAM ahead (Land, 2013). In addition, Arikunto (2013) states, if data generated from a valid product, it can be said that products be developed already provides an overview of the purpose of developing the company properly and fit the reality or the real state. After the module is declared valid by the validator and practitioner, so the revision of the module in accordance with the validator advices. Module able to make students learn independently because it is easy to use, easy to understand material, do some STEAM activity and presented by interesting materials. According to (Zulkarnain & Tanjung, 2023) , integration of the STEM approach in learning can support mastery of science process skills.

CONCLUSION AND SUGGESTION

Conclusion

From the results of the research it could be concluded that the module based on STEAM which has been developed is declared valid by the validator. This states is according to an average of 89.6% with a very valid category. The STEAM module can be used as an alternative or innovation that support teaching and learning activities especially to increase science process skill.

Suggestion

The advice that can be given in this study is that it is necessary to implement this teaching material in schools to determine the level of effectiveness of teaching materials to improve primary school student’s science process skill.

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