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VALIDATION OF STEM PROJECT-BASED LEARNING MODULE FOR ELEMENTARY SCHOOL SCIENCE LEARNING

Riski Septiadevana[1], Norazilawati Abdullah[2*]
[1,2]Faculty of Human Development, Universiti Pendidikan Sultan Idris, Malaysia
[1]Primary School Education, Sekolah Tinggi Pendidikan Holistik Berbasis Karakter, Indonesia
devana.kiky@gmail.com[1], nora@fpm.upsi.edu.my[2*]

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ABSTRAK

STEM (Science, Technology, Engineering, and Mathematics) Project-based learning can provide opportunities for students to solve problems while developing 21st century skills. In the learning process, teachers can use the module to be applied independently and adapt project-based STEM learning to the conditions of their respective schools. The purpose of this research is to validate the project-based STEM module that has been produced in the previous stage in order to meet the criteria of a quality teaching module. Data were obtained from seven experts in STEM education, science education, and basic education. The instrument used was a questionnaire which included six indicators of module validity assessment, namely; learning objectives, module content, module format and language, module presentation, module usability, and module assessment. The data was processed using percentage and CVI (Content Validity Index). The results showed that all module validity items obtained a percentage value of 87.76% and an average CVI value of 0.985. This means that the module both in terms of percentage value and CVI are classified as high. This study provides implications in determining methods for assessing module content validity that can be applied in future research. Nonetheless, further research is needed to assess the module, such as through usability assessment of the module or experimentally

A. INTRODUCTION

The changes that occur in the 21st century can affect various aspects of life, including in the field of education. Preparing students to be able to compete in the face of 21st century globalization is an important agenda today (Berg et al., 2021). In general, the skills that students need to have to answer the challenges of the 21st century include collaboration, communication, creativity and critical thinking (Herlinawati et al., 2024; Obi et al., 2022). Specifically in science learning, critical thinking skills and scientific literacy are two important competencies needed in learning (Wang et al., 2019; Suardana et al., 2018). In addition, one of the characteristics of successful learning is learning that makes students actively involved in learning or in solving problems. One of the impressive approaches that can be used in science learning is through a STEM approach. STEM stands for Science, Technology, Engineering, and Mathematics. While the integrated STEM approach is defined as a method that combines the teaching and learning process between two or more STEM subjects, or connects STEM subjects with one or more other subjects in school (Sanders, 2009).

Teachers often use the STEM approach to present real-life contexts and problems and make learning more interesting. This approach is believed to be able to support the achievement of affective and cognitive aspects in science learning, increase student interest, and encourage them to solve problems during the learning process. In its implementation, the STEM approach alone is not enough, the STEM approach can be combined with project-based learning and can be called STEM-PjBL. Through project-based STEM learning, students can solve problems in groups, and can support the achievement of skills needed in the 21st century.

At elementary school or junior high school level, STEM learning can be carried out in science subjects. Where science learning is the core or topic of learning and is carried out with a STEM approach which combines the fields of technology, engineering and mathematics in learning.

Although STEM education has many advantages, in reality STEM learning is still rarely implemented, especially at the elementary school level. This happens because there are obstacles such as lack of teacher experience, lack of teaching materials that emphasize STEM, difficulties in selecting projects in the context of the field being studied, and challenges in finding effective learning strategies (Septiadevana & Norazilawati Abdullah, 2024). In fact, STEM learning is not as complicated as imagined. For elementary school level, the goal of STEM learning is to introduce STEM and also to motivate students in learning. Therefore, STEM learning at elementary school level must be designed as fun as possible so that students are interested and motivated in this field.

Therefore, teachers need to be equipped with competencies to better understand and be more skilled in designing and implementing STEM learning. Things that can be done include teacher training or workshops on STEM education, providing modules, teaching materials, and easy access to these things (Fathoni et al., 2020).The provision of textbooks, teaching materials, and even modules that support 21st century learning is needed to overcome the problem of teachers who still have minimal knowledge and practical examples in implementing STEM education in learning (Bayu et al., 2023; Sulistiyanti et al., 2021). Therefore, providing quality STEM teaching materials or modules is a natural thing to do.

Through the teaching modules, teachers can see it as a guide and can implement it independently and also have the freedom to implement STEM learning according to the conditions in their respective schools but still within the appropriate STEM learning corridor. STEM Project-based teaching modules have been produced in the previous stage. Meanwhile, the purpose of this study is to validate the STEM project-based learning modules to meet the criteria for quality STEM teaching modules.

B. RESEARCH METHODOLOGY

This study is part of Design and Development Research (DDR) approach by Richey and Klein (2007), which consists of three phases, namely the needs analysis phase, the design and development phase, and the evaluation phase (Richey & Klein, 2007). This paper presents the results of the validation process of the developed module, which is a stage of the design and development phase.

The module validity test was conducted using a questionnaire adapted from Torrefranca and Rodriguez (2017), which consists of six indicators including: (1) learning objectives, (2) module content, (3) module format and language, (4) module presentation, (5) module usability, and (6) module assessment.

Then, the validation results were analyzed using percentages and CVI. The following is the formula used to obtain content validity from experts through frequency and percentage:

$$\frac{Total\ expert\ score}{Maximum\ score}\ x\ 100\% = Module\ validity\ achievement$$

After the module validity value was obtained, the researcher also obtained the content validity index (CVI) value from the same data source. To obtain the CVI value, the researcher followed Govindasamy et al., (2024).

$$S - CVI/Ave = \frac{tota\ I - CVI\ score}{number\ of\ items}$$

Table 1 below shows the accepable CVI values according to the number of experts involved. Research findings on the contents of this module are said to meet the requirements if they receive approval above 70% (Baity et al., 2019; Sidek & Jamaludin, 2005) and the S-CVI/Ave value exceeds 0.8 (Govindasamy et al., 2024).

Table 1. CVI Value According to the Number of Experts

Number of Experts	Acceptable CVI Values	Source Recomendations
Two experts	At least 0.80	Davis (1992)
Three to five experts	Should be 1	Polit & Beck (2006), Polit et.al (2007)
At least six experts	At least 0.83	Polit & Beck (2006), Polit et.al (2007)
Six to eight experts	At least 0.83	Lynn (1986)
At least nine experts	At least 0.78	Davis (1992)

The validity of the STEM-PjBL module was evaluated by seven experts in their fields. In detail, 4 university lecturers in science education or STEM, 2 university lecturers in elementary school education, and 1 staff member from the Ministry of Education's science education division. The determination of the number of seven experts is supported by research stating that comments, input, and evaluation of responses from seven experts can ensure that the contents of the developed module achieve a good level of validity. The experts who evaluated the validation of the module numbered are seven people who came from the fields of STEM education, primary school education and science education.

C. RESULT AND DISCUSSION

After the module is produced, a validity test needs to be carried out on the module. Content validation is carried out by experts who have expertise, experience and relevance to the product being developed, namely the STEM teaching module based on project learning (STEM-PjBL). If we look at the interpretation of validity in the context of research, validity refers to the appropriateness, meaningfulness, accuracy and usefulness of each conclusion made by researchers based on data collected through the instrument (Fraenkel et al., 2012). Furthermore, evidence of validity related to content includes an assessment of the content and logical structure of the instrument, according to how the instrument will be used in a particular study.

1. The Overall Quality of STEM-PjBL Learning Module

The STEM-PjBL module that has been developed is assessed and validated by experts covering six dimensions or indicators of validity quality assessment consisting of; learning objectives, module content, module format and language, module presentation, module uses, and module assessment with a different number of items for each dimension by adapting the Torrefranca & Rodriguez (2017) module validation instrument. The six dimensions are analyzed to determine the level of validity of the module content in the form of a percentage representing each expert. The average percentage and S-CVI/Ave score for each module validation dimension are presented in Table 2.

Table 2. Percentage and CVI Value for Validation Module Component

Indicator	Percentage (%)	S-CVI/ Ave
Learning objectives	90.48	1
Module content	84.92	0.97
Module format and language	87.50	1
Module presentation	89.29	1
Module uses	90.00	0.97
Module assessment	85.00	0.97
Average	87.76	0.985

Since content validity requires in-depth statistical evaluation and aims to see whether the measurement has been carried out, two aspects of content validity are carried out, namely through the percentage of frequency and CVI. The validity of the module for all indicators both in terms of percentage value and CVI is considered high. This finding is in line with the research of Mohamed Abdelmohsen (2020) dan McWhirter & Shealy (2018) who stated that the CVI value or percentage can be used to show good and sufficient validity.

Based on the figure table, the average content validity percentage of the entire content of The module shows a result of 87.76% and all of them are at a high level. Likewise, S-CVI/Ave are all above 0.83 (seven validators) and indicate that all dimensions in the module are valid.

2. The Learning Objectives of STEM-PjBL Learning Module

The learning objectives of STEM-PjBL reached a percentage of 90.48% with an S-CVI/Ave value of 1. Table 3 shows that the learning objectives in this module obtained very high content validity.

Table 3. Detail of Percentage and CVI Value for Learning Objectives Module Components

No	Learning Objectives Components	Percentage (%)	S-CVI/ Ave	Category
1	Learning objectives for each project/sub-topic are based on learning outcomes	92.86	1	High
2	Learning objectives for each project/sub-topic are expressed in measurable behaviors	89.29	1	High
3	Learning objectives lead to the achievement of learning outcomes	89.29	1	High
	Average and S-CVI/Ave	90.48	1	

The percentage of content validity accepted must exceed 70%, and the CVI value must be equal to or greater than 0.83 (≥0.83) if the number of experts is seven (Lynn, 1986). For learning objectives, one question item achieved a content validity of 92.86% and two questions achieved a content validity of 89.29%. This finding indicates that STEM-PjBL module meet targets in science learning. In science learning, students need to be given the opportunity to express conceptual understanding or demonstrate their skills or behavior so that students can have problem-solving skills and attitudes in the context of everyday life in order to change student behavior for the better (Das et al., 2022; Bybee et al., 2006).

Although it has not reached a value of 100%, the question item still shows a high percentage and acceptance among experts towards the learning objectives in the module. In addition, the proportion of content experts for each learning objective item in the module shows an I-CVI value of 1, while the average score of all questions shows an S-CVI/Ave value of 1. Overall, the learning objectives in this module obtain very high content validity from the frequency findings, the percentage showing an average value of 90.48 with an overall I-CVI and S-CVI value of 1 for the learning objective aspect in the module.

2. The Module content of STEM-PjBL Learning Module

The module content of STEM-PjBL reached a percentage of 84.29% with an S-CVI/Ave value of 0.97. Table 4 shows that the module content in this module obtained very high content validity.

Table 4. Detail of Percentage and CVI Value for Module Content Components

No	Module Content Components	Percentage (%)	S-CVI/ Ave	Category
1	The content of the module meets the learning objectives	85.71	1	High
2	Complete module content in terms of learning steps	82.14	0.86	High
3	Complete module content in terms of assessment	82.14	1	High
4	Module content meets characteristic of the 21st century learning	85.71	1	High
5	Task/project given according to student's level	85.71	1	High
	Average and S-CVI/Ave	84.29	0.97	

Overall, the module content obtained high content validity from the frequency findings, percentages and CVI. The content of a good module is one that can fulfill the purpose of creating the module and is in accordance with the student's achievement targets (Sidek & Jamaludin, 2005).

3. The Module Format and Language of STEM-PjBL Learning Module

The module format and language of STEM-PjBL reached a percentage of 87.50% with an S-CVI/Ave value of 1. Table 5 is the content validity findings for the module format and language.

Table 5. Detail of Percentage and CVI Value for Module Format and Language Components

No	Module Format and Language Components	Percentage (%)	S-CVI/ Ave	Category
1	The module layout format is well laid out and makes learning more interesting	89.29	1	High
2	The language used is easy to understand	89.29	1	High
3	The language used is clear, precise, and motivating	85.71	1	High
4	The instructions in this module are precise and easy to follow	85.71	1	High
	Average and S-CVI/Ave	87.50	1	

Table 5 shows that the module format and langage in this module obtained very high content validity. Modules that have a clear layout and language, are appropriate to the level of student understanding, and are structured with a good language structure can help students understand the material and carry out learning activities, so that the module can be used effectively in the teaching and learning process (Dwikoranto et al., 2023).

3. The Module Delivery of STEM-PjBL Learning Module

The module delivery of STEM-PjBL reached a percentage of 89.29% with an S-CVI/Ave value of 1. Table 6 is the content validity findings for the module delivery in the module.

Table 6. Detail of Percentage and CVI Value for Module Delivery Components

No	Module Delivery Components	Percentage (%)	S-CVI/ Ave	Category
1	Topics are presented in an orderly and logical sequence	89.29	1	High

2	The learning delivered is unique and original	92.86	1	High
3	Learning activities are clearly stated	82.14	1	High
4	The presentation of each lesson attracts student's attention	89.29	1	High
5	Sufficient examples of each topic/project	92.86	1	High
	Average and S-CVI/Ave	89.29	1	

Table 6 shows that the module delivery obtained very high content validity. A good learning process does not only consist of delivering material, but also through direct experience by students. Especially in science learning, this can be done by applying scientific methods in class activities such as experiments or practicums (Zainuddin et al., 2021). Good science teaching modules must be developed to train students' science process skills and scientific attitudes and systematically.

4. The Module Usage of STEM-PjBL Learning Module

The module STEM-PjBL usage reached a percentage of 90.00% with an S-CVI/Ave value of 1. Table 7 is the content validity findings for the module usage in the module.

Table 7. Detail of Percentage and CVI Value for Module usage Components

No	Module Usage Components	Percentage (%)	S-CVI/ Ave	Categor y
1	The activities in the module allow students to master the learning topic well	85.71	1	High
2	Activities in the module enable students to learn actively and meaningfully	96.43	1	High
3	Module content can be adapted to the needs of students	92.86	1	High
4	The STEM-PjBL module will develop student scientific literacy skills	92.86	1	High
5	The STEM-PjBL module will develop students's criitical thinking skills	82.14	1	High
	Average and S-CVI/Ave	90.00	1	

Table 7 shows that the module usage obtained very high content validity. Modules used appropriately can help students improve and move towards a student-centered approach (How et al., 2024).

5. The Assessment of STEM-PjBL Learning Module

The module assessment of STEM-PjBL reached a percentage of 85% with an S-CVI/Ave value of 0.97. Table 8 is the content validity findings for the module assessment.

Table 8. Detail of Percentage and CVI Value for Module Assessment Components

No	Module Assessment Components	Percentage (%)	S-CVI/ Ave	Categor y
1	The assessment given is in accordance with the learning objectives	82.14	1	High
2	The assessment given can measure the level of achievement of learning objectives	85.71	1	High
3	Student assessment components are in accordance with the content of the module	82.14	0.86	High
4	Assessment can be done by using student worksheets in the module	92.86	1	High
5	Assessment can be done by using formative assessment in the module	89.29	1	High
6	Evaluation can be done by using the product evaluation rubric in the module	82.14	1	High
7	Evaluation can be done by using the presentation evaluation rubric in the module	89.29	1	High
8	Assessment can be done by using the self-assessment sheet that is in the module	89.29	1	High

9	Summative assessment question details are in accordance with scientific literacy indicators	82.14	1	High
10	The details of the summative assessment questions are in accordance with the indicators of critical thinking skills	75.00	0.86	High
	Average and S-CVI/Ave	85	0.97	

Table 8 shows that the assessment in this module obtained very high content validity. In the Merdeka curriculum, assessment is divided into diagnostic assessment, formative assessment, and summative assessment (Budiono & Hatip, 2023). Likewise with the modules that are developed, there are three types of assessments that are adjusted to the learning objectives and expected competencies.

D. CONCLUSION AND SUGGESTION

The content validity of the developed module is high for all module validity items, namely; learning objectives, module content, module format and language, module delivery, module use, and evaluation in the module. The results of this study have a positive impact on the practice of teaching and learning science at the elementary school level. This study contributes to the development of the use of learning modules that focus on solving contextual problems through a project-based STEM approach, as a step to foster and increase students' interest in the STEM field in order to prepare them for future career demands. Therefore, further research is needed to assess the module at elementary school level, such as through assessing the usability of the module or experimentally, both quantitatively and qualitatively.

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