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VALIDITY OF THE PROBLEM-BASED LEARNING MODELLEARNING TOOLS BASED ON THE STEAM APPROACHON STUDENTS' CRITICAL THINKING SKILLS

Yuliyanti Kohohon, Mursalin, Muhammad Yusuf
Master of Physics Education, Postgraduate Program, Universitas Negeri Gorontalo

ABSTRACT: The utilization of instructional tools, such as learning devices, is essential for educators to facilitate optimal learning outcomes. These tools can enhance active participation and support the development of creative thinking and critical thinking skills. The implementation of appropriate pedagogical models and approaches can enhance students' critical thinking abilities. This study posits that the Problem-Based Learning (PBL) model, when integrated with the Science, Technology, Engineering, Arts, and Mathematics (STEAM) approach, can effectively cultivate critical thinking skills in students. The objective of this study is to ascertain the validity of the physics learning resources for senior high school students, which are based on the problem-based learning (PBL) approach and incorporate the STEAM (science, technology, engineering, arts, and mathematics) methodology. The learning resources include the following: the lesson plan, the student workbook, the instructional materials, and the critical thinking assessment. This study employs a descriptive-quantitative research approach. The results of the study indicate that the percentage of validity for the RPP is 93.18%, for the LKPD is 92.59%, for the instructional materials is 90.83%, and for the critical thinking test is 92.71%. Therefore, the developed instructional materials are highly valid for use in the learning process.

KEYWORDS:*Learning Tools, Problem-Based Learning, STEAM Approach, Critical Thinking Skill*

I. INTRODUCTION

The advent of the digital age has had a profound impact on society, particularly in Indonesia. This impact can be observed in various sectors, including education, culture, social structures, economics, and industry. One notable example is the advent of the fourth industrial revolution, which has led to a shift in the educational landscape, with an increasing emphasis on competitiveness due to the rapid advancement of information technology in the 21st century.

In the 21st century, education must align with technological advancement. Education plays a pivotal role in equipping learners with the skills to learn, innovate, utilize technology and media, and function effectively in the workplace, all while developing life skills (Murti, 2015). In the current 21st century, students are expected to develop skills that will enable them to respond effectively to changes and developments in the modern world. They must also possess a deep understanding of knowledge and a lifelong commitment to learning (Afandi et al., 2016).

The achievement of competencies by learners in the 21st century is contingent upon their intrinsic capabilities. A robust desire to learn and a sense of dependence on instruction will motivate learners to engage in rigorous study as a means of developing their abilities, skills, and knowledge. In reality, a significant proportion of students are unable to achieve the desired outcomes due to a lack of interest and motivation. Consequently, the graduates produced are unable to address the challenges and issues of the 21st century, as they do not meet the required qualifications.

One potential avenue for fostering critical thinking skills in students is through the implementation of STEAM (science, technology, engineering, arts, and mathematics) learning. STEAM-based projects integrate various disciplines within the STEAM framework, thus providing a unique opportunity for students to engage in hands-on learning experiences. Wilson & Hawkins (2019) demonstrate that STEAM learning enables students to appreciate how the arts and sciences collaborate to utilize a multitude of critical thinking, creativity, and imagination skills when attempting to comprehend tangible issues. The concept of STEAM is described in various ways, with at least four types of disciplinary integration: transdisciplinary, interdisciplinary, multidisciplinary, and cross-disciplinary (Marshall, 2014).

In his 2011 work, Sudargo posits that the Problem-Based Learning (PBL) model enables students to engage with contemporary, real-world issues, aligning their learning with authentic, student-centered contexts. This approach, he suggests, stimulates higher-order thinking. Furthermore, Amir (2009) posits that the Problem-Based Learning (PBL) model offers numerous benefits, including; (1) enhancing students' memory and comprehension of taught material, (2) directing students' attention towards relevant knowledge, (3) encouraging students to think critically, (4) fostering teamwork, leadership, and social skills, (5) developing learning skills, and (6) motivating students to engage in learning. According to Suprihatiningrum (in Yahdi, et al., 2020), Problem-Based Learning (PBL) is defined as a problem-based learning model that involves a series of activities, both in groups and individually, to address real-world problems. This approach requires students to engage in critical thinking, communication, exploration, and problem-solving, applying scientific reasoning.

The academic achievements of students are largely determined by their intellectual and cognitive development. Cognitive development is a psychological process involving the acquisition, organization, and utilization of knowledge, as well as mental activities such as reasoning, weighing, observing, remembering, analyzing, synthesizing, evaluating, and problem-solving. These processes occur through interactions with the surrounding environment. The cognitive development of students is contingent upon interactions between various aspects of their development, including those with their peers and the environment. This process enables students to enhance their cognitive abilities, evidenced by their ability to engage in critical thinking.

The process of critical thinking is an integrated one that enables an individual to evaluate evidence, assumptions, logic, and the language used to express ideas. Furthermore, critical thinking is a deep-thinking process that involves investigating, exploring, experimenting, and other methods to gain accurate insights and construct knowledge in a meaningful way. The process of critical thinking can be undertaken in several stages, including interpretation, analysis, evaluation, inference, and explanation.

A review of the current instructional methods employed in the educational setting revealed that the prevailing pedagogical approach remains largely confined to traditional lecture-based and assignment-driven learning models. This has resulted in a lack of opportunities for learners to fully engage with their inherent cognitive abilities. This observation highlights a critical need for a more comprehensive and inclusive approach to learning that can effectively accommodate the diverse learning styles and abilities of each student.

To this end, it is essential to implement strategies that enhance the learning experience, foster engagement, and facilitate the development of critical thinking skills. These efforts must be accompanied by a commitment to innovation and creativity in the design of learning environments that prioritize the needs and interests of learners.

One of the learning models that supports the enhancement of critical thinking abilities and the advancement of 21st-century education, as well as one that has been endorsed by the Indonesian government through the Ministry of Education, Culture, Research, and Technology in the 2013 curriculum, is the Problem-Based Learning (PBL) model. This model of learning is centered on contextualized problems, which are designed in a way that encourages students to actively deepen their knowledge to solve the problems presented to them. Students are required to utilize a range of cognitive abilities to independently identify pertinent sources, theories, and concepts pertinent to the problem at hand.

II. METHODS

This study employed a descriptive research design to assess the validity of problem-based learning (PBL) model-based STEAM learning tools in fostering critical thinking skills in learners. To this end, the study employed a validation process involving experts and scholars in the field. These experts were tasked with evaluating the instruments used in the study, providing feedback and commentary on their suitability and effectiveness. The instruments utilized in this study were the assessment of the validity of the instructional materials (RPP, LKPD, instructional materials, and critical thinking assessment). The results of the validation conducted by the experts/professionals served as the foundation for the improvement of the instructional materials. The results of the assessment of the validity were obtained from the scoring of the instructional materials by the validators using the Likert scale, with a range of scores from 1 to 4. The analysis of the expert validation was conducted in the following manner:

$$Validity = \frac{Total\ score\ from\ validators}{Total\ score} \times 100\%$$

The validated results will be compared to the criteria outlined in Table 1 (Akbar, 2013) to ascertain the percentage of valid results.

Table1.Validity Criteria of the Learning Tools

Percentage	Validity Criteria
85,1% - 100%	Very Valid
70,1% - 85%	Valid
50,1% - 70%	Less Valid

0,1% - 50%	Invalid

III. RESULTS AND DISCUSSION

The initial instructional design was subjected to validation by experts. All experts or validators provided feedback on the instructional design, including suggestions for improvement. The comments and suggestions for improvement provided by the validators for the developed instructional design can be found in Table 2.

Table 2.Comments and Suggestions from Experts

No.	Validator	Comments and Suggestions
1	Validator 1	RPP: ❖ The selected vocabulary must adhere to the grammatical structure of the Indonesian language, specifically the SPOK (subject, predicate, object, and complement) pattern. ❖ In the preliminary phase, specifically in phase 1, the teacher's role is to present the issue in a more specific manner. Teaching materials: ❖ The images included in the material must be more visible and clearer.
2	Validator 2	RPP: ❖ The Indicator of Achievement of Competence (IPK) is defined in accordance with the Basic Competence Standards (BCS). ❖ The principles of formulating learning objectives must incorporate the elements designated as ABCD (Audience, Behavior, Condition, and Degree). LKPD: ❖ The LKPD must be developed in a manner that more clearly reflects the model of PBL that is being implemented. Critical Thinking Test: ❖ The developed tests align with the indicators of critical thinking.
3	Validator 3	LKPD: ❖ The issues addressed in the LKPD must align with the learning objectives. Teaching Materials: ❖ It is imperative that instructional materials include clear and accurate visual representations accompanied by a clear and concise source attribution. Critical Thinking Test: ❖ It is important to consider the difficulty of the question.

Table 2 indicates that the comments and suggestions for improvement provided by the experts through focus group discussions (FGDs) will be incorporated into the revised research proposal before the commencement of the study. Following the incorporation of these revisions, the developed instructional materials can be utilized in accordance with the recommendations and corrections provided by each of the experts. In addition to providing feedback, the experts also evaluate the developed instructional materials using the assessment instruments developed by the researchers. The results of the validators' assessments are presented in Table 3.

Table3.Average Percentage of Validation Results by Experts

No.	Instrument of Validation	Percentage	Criteria
1	Learning Implementation Plan (RPP)	93,18%	Very Valid
2	Student Worksheet (LKPD)	92,59%	Very Valid
3	Teaching Materials	90,83%	Very Valid
4	Critical Thinking Skills	92,71%	Very Valid

Table 3 indicates that the learning tools developed by the researchers are highly valid and suitable for further testing. This conclusion is based on the fact that the average validation score falls within the "highly valid" range, as determined by the assessment of the expert evaluators.

According to Buhungo, T.J. et al. (2021), the validity of the instructional materials is determined by the opinions of professional experts and by a comprehensive review of the materials as a whole. The experts assess the construction, content, language, and presentation of each instructional material. As posited by Fatmawaty (in Hadis, et al. 2022), the consistency between the interconnectivity of each component within the development of

instructional materials and the characteristics of the integrated pedagogical model will contribute to the perceived validity of the instructional materials.

The results of the validation of the Problem-Based Learning (PBL) model-based STEAM approach indicated that the researchers should address several issues identified by the validators. The validation process involved experts evaluating each component of the learning materials, including the lesson plan, student workbook, instructional materials, and critical thinking assessment. This comprehensive approach involved in-depth analysis and recommendations for improvement. The results of the RPP validation indicated several areas in need of improvement. The first recommendation from the expert reviewers pertained to the use of sentences containing the SPOK structure (subject, predicate, object, and complement) in accordance with the rules of Indonesian grammar. This observation aligns with the findings of previous research by Arman et al. (2020). In 2020, it was stated that the sentences in the RPP, which is a learning tool, must be structured correctly and clearly. The use of the SPOK pattern will assist in the construction of more structured sentences, thus facilitating comprehension and enhancing the quality of communication in the learning tool.

The second corrective measure emphasizes the initial phase of the process, during which the teacher's role in articulating the problem should be more specific. This finding aligns with the findings of Mayasari et al. (2016), which underscores the significance of the teacher's role in orienting students to the problem at hand, thereby enhancing clarity in the presentation of the problem, which in turn can facilitate greater student engagement. Consequently, it is essential to provide more detailed instructions on how to present the problem in order to align with the students' comprehension and interest levels. This could involve the use of media or questions designed to stimulate students' interest and critical thinking.

The third recommendation pertains to the improvement of the Indicators of Achievement (IPK) in accordance with the Competency Standards (CS). This is of paramount importance as it directly affects the final competencies that students are expected to attain. If the IPK does not align with the CS, the learning process will lack a clear orientation towards the desired learning outcomes (Ariyana et al., 2018). Previous research by Noto (2014) indicates that a precise and detailed explanation of the IPK in relation to the KD is essential for the clear measurement of learning outcomes. Consequently, the RPP must be updated to ensure that each IPK accurately reflects the desired concepts and abilities to be achieved in the learning process.

The fourth improvement recommendation emphasizes the importance of formulating learning objectives that incorporate the elements of the ABCD framework (Audience, Behavior, Condition, and Degree). As Sutikno (2021) asserts, the ABCD approach to learning objective formulation facilitates clarity regarding the desired outcomes and the means of achieving them. Consequently, the RPP must be improved to ensure that each learning objective aligns with the ABCD principles, thus providing clear guidance for educators and learners. Overall, the suggested improvements to the RPP can be integrated with previous research findings to ensure that each aspect of the RPP meets the highest quality standards. By implementing these improvements, the RPP can serve as a more effective guide for implementing problem-based learning approaches based on the STEAM approach to foster critical thinking skills in students.

The validation of the Student Activity Worksheet (SAW) by experts yielded the initial recommendation for improvement, which centered on the necessity to develop the SAW in a manner that more closely aligns with the principles of Problem-Based Learning (PBL) throughout the learning process. Previous research (Pitriyana & Arafatun, 2022; Ansyah et al., 2021) indicates that elements of PBL, such as problem identification, question formulation, and independent exploration, should be more prominent in LKPDs to align with the principles of PBL. Such improvements may entail the incorporation of additional steps or instructions that specifically reflect the PBL process, ensuring that learners are actively and independently engaged in their learning.

The second improvement suggestion emphasizes the necessity of aligning the issues discussed in the LKPD with the learning objectives. Previous research has demonstrated the significance of aligning the issues with the learning objectives, which can facilitate the achievement of competencies (Lutfa, 2014). Therefore, it is essential to update the LKPD to ensure that each issue presented directly supports the achievement of the learning objectives, thereby establishing a strong connection between the content and the students' activities. In integrating these suggestions, the LKPD can serve as a more effective tool for guiding students through the PBL process and ensuring that each element of the activity sheet aligns with the established learning objectives.

The validation process conducted by experts on the instructional materials focused on the necessity for improvements in the images utilized, which must be clear and sourced from reliable sources. Previous research by Hariadi (2016) and Fiteriani et al. (2021) demonstrated that images in instructional materials must be clear to have a significant impact on student comprehension. Consequently, the proposed improvements align with the aforementioned findings, emphasizing the significance of clarity in images to facilitate conceptual understanding. Images must be relevant, of high quality, and sourced from reliable sources (Riastuti & Febrianti, 2021) to ensure that the information conveyed through images is effectively communicated to learners. Consequently, in the process of updating instructional materials, it is essential to ensure that the sources utilized for images and other content are verifiable and possess a high degree of accuracy. The utilization of reliable

sources will enhance the credibility of the instructional materials and ensure that learners can rely on the information presented.

The validation of the Critical Thinking Skills Test by experts yielded initial suggestions for improvements, particularly regarding the alignment of the test with the indicators of critical thinking. The findings of the study conducted by Jamaluddin et al. (2019) indicate that a well-designed critical thinking skills test should reflect the aforementioned indicators. Therefore, it is essential to ensure that each question on the test accurately assesses the specific critical thinking skills that are intended to be evaluated. Such improvements may entail adjustments to the items on the test to align them with the established indicators of critical thinking.

The second corrective measure focuses on the importance of considering thedifficulty level of the questions. Previous research by Adhitya et al. (2022) indicates that the difficulty level of the critical thinking skills test questions should be adjusted to encompass a range of student abilities. Consequently, it is necessary to modify the difficulty level of the questions to ensure that the test can identify and assess students' critical thinking skills holistically. Such adjustments may entail further analysis of the relative difficulty of each item and the adjustment of its level of difficulty to align with the desired outcome. Based on the feedback and suggestions from several validators, the researchers conducted further revisions to enhance the validity of the developed learning materials, resulting in a highly valid instrument with minimal revisions that can be utilized in subsequent stages.

IV. CONCLUSION

The results of the data analysis indicate that the Problem Based Learning (PBL) model based on the STEAM approach is highly valid. This conclusion is supported by the validation results, which demonstrate that the average validation score for the PBL model is between 90.83% and 93.18%.

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