

Validity and Practicality of STEM PjBL Learning Tools for Respiratory System Material

by Saiful Ridlo

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Kumiahtunnisa
Universitas Negeri Semarang
kumiahtunnisa@gmail.com

Yustinus Ulung Anggraito
Universitas Negeri Semarang
y.ulung.anggraito@mail.unnes.ac.i
d

Saiful Ridlo
Universitas Negeri Semarang
saifulridlo@gmail.com

Abstract--The 2013 curriculum is intended to develop students' 4C skills. The basic competence of respiratory system material will be appropriately implemented by PjBL and STEM. The research purpose is describing the validity and practicality of learning tools. This research belongs to *research and development* particularly to the measurement of validity and practicality. Data Analysis used descriptive quantitative and percentage. The findings: (1) learning tools were very valid include syllabus with score 88.54; the lesson plan with score 86.91; learning material with score 85.54; students' worksheet with score 85.83; the evaluative instrument with score 86; construct validity of Critical Thinking test obtained $r_{\text{calculated}} 0.54 > r_{\text{table}} 0.304$, reliability test was 0.70 – meaning the test was valid and reliable. (2) Learning instrument was practicable. This research adds scientific insight especially about learning tools that are able to train students' 4C skills. In conclusion, the STEM PjBL learning tools was valid and practicable.

Keywords: STEM PjBL learning instrument, validity, practicability

I. INTRODUCTION

Achieving success in 21st century learning requires learning skill and innovation in the 2013 curriculum termed 4C capabilities including critical thinking skills and problem solving, creativity and innovation, communication, and collaboration¹. In line with the competence or skills that should be owned by the students over the 21st century, the learning process in the 2013 curriculum is intended to develop the students' 4C skills. Critical thinking skill is a thing that underlies a person to overcome the problems he or she faces. Critical thinking skill is one of the highest sequences of cognitive abilities and are recognized as the main competencies in education, especially for science and technology². Besides the ability to think critically, the ability that students need to have is the ability to think creatively. Creativity helps students in solving the challenge, thinking exclusively, and social action³. The ability to think creatively and creativity needs to be supported by the ability to communicate and collaborate. Therefore, in line with the demands of the 2013 Curriculum 4C skills are important for students to have.

However, based on the previous studies, teacher learning has not led to any improvement in

students' high-level thinking skills (4C skills). Previous studies conducted in five schools in the form of filling out questionnaires by students related to the learning process they had obtained, 47% said the methods used by the teacher were lectures, 37% discussion methods, and 22% other methods. Overall the lesson plan developed by some teachers has paid attention to the 4C aspects, but the learning process designed has not clearly described the stages to develop the 4C abilities of students. This was confirmed by the student questionnaire about the project, 76% of students answered that they had never designed the project in groups, while 24% of students answered that they had designed the project but had not done it independently. However, the learning process carried out has not clearly described the stages to develop the 4C abilities of students so that it will have an impact on students' ability to work on evaluation questions. Based on the results of the interview, the teacher has never developed a learning device or contextual and integrative teaching material such as the approach to *science, technology, engineering, and mathematics* (STEM) which is oriented to the development of high-level thinking skills of students.

The STEM approach is an integration between four disciplines which are *science, technology, engineering, and mathematics* in an interdisciplinary approach based on real world contexts. The characteristics of STEM learning are very relevant with the 2013 curriculum. As stated in the 2013 curriculum document that one of the improvements in thought developed in the 2013 curriculum is the strengthening of multidisciplinary learning patterns and strengthening critical learning patterns⁴. STEM learning is suitably integrated with project-based learning because it involves many different academic skills that are appropriate in building conceptual understanding through assimilation of different subjects⁵. The results of the meta-analysis of 34 articles from STEM research published between 1996-2016 revealed that STEM education had an effect on academic achievement, problem solving skills, creative thinking skills and scientific attitudes, and science process skills⁶. Project-based learning increases student academic achievement⁷. Therefore, learning with the STEM PjBL approach can be one of

the learning alternatives to support the achievement of 4C skills, so it is necessary to develop the PjBL STEM tools.

Based on this background, this study will develop learning tools, analyze the implementation and practicality of PjBL STEM learning tools. Thus, the research is carried out with the title : "Validity and Practicality of STEM PjBL Learning Tools for Respiratory System Material".

II. METHOD

This *research and development* specializes on measuring validity and practicability of developed STEM PjBL learning tools such as syllabus, lesson plan, student worksheet, learning material, and evaluative instrument. On the product development process, expert judgment was done to find out validity of the product seen on content and construct validities. It was done by content, learning design,

and educational practitioner experts. The subjects of massive scaled test consisted of 106 students from three eleventh grader classes of Senior High School 16 Semarang. The data analysis were quantitative descriptive and percentage.

III. RESULTS AND DISCUSSION

The results of the research obtained included the validity of the STEM PjBL learning tools by experts and the practicality of the PjBL STEM learning tools.

3.1 Validity of Learning Tools

Learning tools developed in this study are syllabus, lesson plan (RPP), teaching materials, student worksheets, and learning evaluation. The results of the validation of learning tools by experts are presented in Table 1.

Table 1. Results of Learning Tools Validation

No.	Validated aspects	Average Validator Rating (%)				Criteria
		Validator 1	Validator 2	Validator 3	Average (%)	
1.	Syllabus	90.62	93.75	81.25	88.54	Very valid
2.	RPP	89	93.75	78	86.91	Very valid
3.	Teaching materials	89.84	-	81.25	85.54	Very valid
4.	LKS	93.33	-	78.33	85.83	Very valid
5.	Evaluation	87	-	85	86	Very Valid

* Detailed data not shown

Based on Table 1, the average results of the validity of the learning tools content is very valid. It shows that the retained earnings validator 1 (Material), the validator 2 (learning design), and the validator 3 (education professionals) provide good assessment of learning tools. A good assessment of the learning device developed, because the learning tools developed in its preparation has fulfilled the aspects that must be considered in the development of

learning tools. The development of learning tools obtained a very valid and feasible category because it was in accordance with the guidelines for the preparation of learning tools⁸.

Validator in giving assessment, also gives comments and suggestions. The following comments and suggestions from the validator and the revised results are presented in Table 2.

Table 2 Results of Comments and Suggestions from Validators

Type of device	Source of revision	Before revision	After revision
Syllabus	Expert validation	· The elements of <i>engineering</i> and <i>mathematics</i> in STEM were not yet clear and on the validation sheet there has been no assessment of STEM elements	· Indicators and learning activities have been developed in accordance with the STEM approach
Lesson Plan	Expert validation	· the RPP component only contained material points and there is no assessment · learning activities in the aspects of <i>engineering</i> and <i>mathematics</i> were unclear and needed to be operationalized	· the material is written in more detail · the learning scenario is clearly explained in stages · indicators use operational verbs
Teaching materials	Small-scale trials, Expert validation	· needed to expand the material so that students understood more details · the PjBL STEM approach was less explicit	· increase the breadth of material · the STEM PjBL approach is already explicit
LKS (Worksheet)	Expert validation	· had not yet determined the work time of the LKS	· there has been an allocation of time to work on LKS
Evaluation	Expert validation	· made balanced evaluation questions for STEM aspects · the answer choices in the question there were no right choices	· he questions developed are proportional to all aspects of STEM · the question is deleted and replaced with new questions

Comments and suggestions from the validator have been followed up and revised so that learning tools are produced with very valid criteria. Overall the evaluation of validator 3 is lower because validator 3 only reaches the initial validation stage, while validators 1 and 2 are done until the final validation stage. The syllabus developed is very valid. Evaluation of validator 1 and validator 2 on aspects of format, content, language, and time are very suitable. Validator 3 assessment on aspects of format, content, and time is appropriate, while aspects of language are very appropriate. The plan for implementing the developed learning is very valid. Validator 1 and 2 assessments on format, content, and language are very suitable. Whereas the validator 3 assessment is lower in the format section because the material and assessment are used as a separate part of the RPP. In general the success of the implementation of learning carried out by a person is very much determined by the quality of the planning made⁹. This lesson plan is the compatibility of the stages of learning with STEM PjBL, so that it can train the students' 4C skills. Implementation of STEM learning encourages students to think critically, have problem solving skills, and improve student achievement¹⁰.

The teaching material developed is very valid. This is because the components of the content feasibility, linguistic components, and presentation components are very suitable. The teaching materials are in accordance with the PJBL STEM approach so that they can train students' high-level thinking skills. The teaching material developed is different from the STEM PjBL teaching material developed before it. Teaching materials that were developed previously on pressure focused on improving student learning outcomes¹¹. STEM-based mobile teaching materials on ecosystem material focused on improving students' scientific literacy¹². The student worksheet developed was very valid. The aspects assessed on student worksheets are material presentation, aspects of activity planning, and appearance was very suitable so that they can train students' thinking skills. Activities in STEM-based worksheets help students to be able to solve problems and make scientific conclusions¹³, can support the improvement of critical thinking skills¹⁴ and students' creative thinking skills¹⁵.

The evaluation developed is very valid because the validator's assessment on material aspects, construction, and language is very suitable. Project-based learning assessment instrument developed was declared valid and reliable so that it was feasible and could be used to measure students' critical thinking skills¹⁶. After performing content validity, it is continued to test construction validity specifically for critical thinking skills testing. The analysis using the *Anates 4.0* program obtained results of r_{count} of 0.54 > r_{table} of 0.304 so that the test items were valid, the reliability of the test was 0.70 so

the question was declared reliable on a strong scale. Questions that have good reliability and validity can measure the critical thinking skills of students¹⁷.

Factors which affect the results of the learning tools validity to be very valid because: (1) the components of the learning tools have been adjusted to the assessment aspects specified in the validity instrument, (2) the learning tools is validated in stages by making improvements according to suggestions and comments at each validation stage, (3) the development of learning tools using communicative language and in accordance with the level of student cognition development, and (4) fulfilling the criteria for content and constructs validity.

3.2 Practicality of STEM PjBL Learning

The assessment of the practicality of learning tools was obtained based on the practicality questionnaire from the teacher after the application of the learning tools. The results of the practicality questionnaire for teacher learning tools are presented in Table 3.

Table 3 . Practical Questionnaire Results by the Teacher

Rated aspect	Practicality of learning tools (%)	Criteria
Feasibility of content	85	Practical
PJBL STEM Approach	81.25	Practical
Stimulates curiosity	75	Practical
Ease and efficiency	100	Very practical
Average	85.31	Very practical

The average practicality of learning devices by teachers is very practical. Learning tools are stated to be very practical by the teacher after fulfilling the requirements for ease of use of the tools, using the STEM PjBL approach, stimulating curiosity, fulfilling aspects of the feasibility of content, and fulfilling guidelines for developing learning tools. The highest percentage of practicality is found in aspects of the ease of use of learning tools. This is because this learning tools is like other learning tools, but it is developed using the PJBL STEM approach. One indicator of learning tools is said to be practical, if the tools is easy to use and can help students understand the material¹⁸. Another factor is a very valid learning tools based on expert judgement. Aspects of practicality can be fulfilled if the practitioner states that what is developed can be applied and the reality shows that what is developed can be carried out well in accordance with the objectives of learning, student-centered, and interaction between students and teachers¹⁹.

IV. CONCLUSION

STEM PjBL learning tools for respiratory system which is developed fulfilling the valid criteria and practical used in learning.

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