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THE VALIDITY AND PRACTICALITY OF THE CHEMISTRY LEARNING DEVICE BY USING STEM - PJBL MODEL

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ABSTRACT

The purpose of this research was to produce the valid and practical learning device using STEM-PJBL to be applied in the chemistry class of Senior High School. The Research was conducted based on the steps of development research according to Borg and Gall. The students of the research included lesson plan, student worksheet, teaching material and evaluation instrument; while the objects of the research were validity and practically of the learning devices themselves. The research was conducted at SMA Negeri 1 Kuta Selatan in March to April 2019, by envolving the XI grade science students as the research population. The data retrieval used validity sheet that was taken by the expert, readability test sheet by teachers and students and students response questionaire about the learning process. The result of the research showed the content of lesson plan as 1, student worksheet as 0,875; material text as 0,80 and evaluation instrument as 0,97; so that all were categorized as valid. The practically score based on the readability of lesson plan as 3,78; student worksheet as 3,68; material text as 3,83; and evaluation instrument as 3,64 ; all were categorized very practical. The practically score of learning device based on the sudents response during the learning process on initial field test was as 4,59 (very practical) and on the main field test was 4,24 (very practical). Therefore, the STEM-PJBL produced in this reseach was categorized in very valid and very practical.

Keywords: Learning devices, STEM-PJBL Model, Chemistry, Validity and Practicality

INTRODUCTION

At present the government through the Ministry of Education and Culture of the Republic of Indonesia has adapted the concept of 21st Century Skills, scientific approach, and authentic learning and authentic assessment to develop education towards creative Indonesia in 2045 (Trilling & Fadel, 2009, Dyer et al. 1999, Wiggins & Mc Tighe, 1998). The creative Indonesian target is supported by research results which show that the highest type of work is creative work, while routine work will be taken over by robotic technology and automation. Creative work requires intelligence and the power of human creativity to produce creative and innovative products (Trilling & Fadel, 2009).

The results of research conducted by Trilling and Fadel (2009) show that high school and college graduates are still less competent in oral and written communication, critical thinking and problem solving, work ethics and professionalism, working in teams and collaborating, working in groups that different, and using technology and project management and leadership. To overcome this problem, Nichols (2013) stated the need to apply the four main principles of 21st century learning, which include: learning approaches must focus on students, education must be collaborative, learning must be contextual, and schools must facilitate students to engage in their social environment .

Based on the findings of Trilling and Fadel (2009), as well as Nichols (2013) view, learning science must be able to integrate scientific literacy with mathematical and language literacy, and learning must be contextual and students are directly involved with their social environment. Those who have scientific and mathematical literacy do critical, rational, and systematic thinking by using symbolic language to solve scientific problems. Those who have scientific literacy will use ability to communicate and speak symbolically and interpret scientific phenomena if their have language literacy.

The fact, based on the results of the 2012 PISA data for Indonesian children, showed several findings including: 1) low literacy outcomes of students, with an average of about 32% for all aspects, consisting of 29% for content, 34% for process, and 32% for context; 2) the diversity between provinces was relatively low regarding to the level of scientific literacy of students; and 3) problem solving skills were very low, far compared to Malaysia, Thailand, or the Philippines (Permanasari, 2016). Furthermore, the results of the 2015 PISA data indicated an increase in Indonesia's ranki with OECD participating countries, but still much lower than the OECD average. Science and mathematics competencies increased, but reading competence has increased by 1 point. Evaluations conducted by the OECD assigned students to be randomly sampled and worked on the main subjects, such as reading, mathematics, and science for 2 hours. These findings indicated the low literacy skills of science, mathematics, and language of 15-year-old students in Indnesia or those who study in grade nine and ten (OECD, 2016).

The problem at the national level is certainly based on the learning at the school level. The promotion of literacy programs, character development education (KDP), and critical thinking skills of students at the school level shows that the government emphasizes the three things that must be known, developed, and owned by students. Through a curriculum made by the government, it is expected that literacy, KDP and 4C capabilities (critical, creativity, collaboration, communication) of students can be significantly improved (permendikbud).

In order for students to improve literacy, KDP and 4C abilities, the learning process requires teachers to be more creative in choosing learning methods that are appropriate to their needs. Choosing the right learning model must pay attention to the condition of the learners, the characteristic of material text, available facilities, and the condition of the teacher. Some learning models that are feasible to be applied in 21st century learning, including the Model Technology Learning Project-Based Learning (STEM-PjBL) developed by Laboy-Rush and intensely socialized by the Research Center for Development and Empowerment of Educators and Educational Personnel (PPPPTK) Science). Research Results Afriana et al. (2016) showed that almost all students expressed pleasure in learning STEM-PjBL and gained a very memorable experience so that their motivation and interest in learning was very high. In addition, students experienced a significant increase in terms of the literacy carried out by students. The research conducted by Capraro et al. (2015) and Ismayani (2016), stated that STEM-PjBL is able to improve creative thinking, critical, analytical, and high-level thinking skills of students. Tseng et al. (2013) revealed that STEM-PjBL can improve effectiveness, meaningful learning, and support the career of students in the future based on experience solving real problems with practical activities in the classroom. Sahin and Top (2015) revealed that the application of STEM with the learning model of PjBL made students active in learning, and they were able to communicate and share findings with their peers.

Considering the importance of the STEM-PjBL model for improving literacy, KDP and 4C abilities of students, learning tools are needed so that they can be implemented in the classroom. For this purpose, researchers have developed learning tools that can be applied to achieve educational goals while answering the challenges of 21st century life. Learning tools that have been developed with reference to the syntax of the STEM-PjBL learning model, include: Learning Implementation Plans (RPP), Participant Worksheets Educate (LKPD), teaching materials in the form of teaching materials, and assessment instruments on the subject of Colloids taught in Class XI High School.

The syntax of the STEM-PjBL learning model, which includes reflection, research, discovery, application, and communication, is very suitable to be applied to the subject of colloids that puts forward the acquisition of new information about colloids by comparing them with the solution and suspension concepts learned by students (reflection stage) , formulating problems related to the properties of colloids (research stage), designing experiments to determine the nature of colloids and their making (discovery stage), conducting experiments on the nature of colloids and their making (application stage), and communicating the results of their investigation (stage communication). The five syntax of the STEM-PjBL learning model are directed to develop students self potential, hone literacy skills, and 4C.

The researcher applied the learning tools of the STEM-PjBL model at SMA Negeri 1 South Kuta since the learning on the subject of Colloids, so far in accordance with the results of preliminary studies conducted in December 2018, was only taught by giving assignments to make papers and be presented. Learning with this method is less able to improve literacy, KDP skills, critical thinking, creativity, and potential of students, even though these abilities are the government's demand to improve human resources to face the challenges of the 21st century.

METODH

This type of research is development research, since research does not intend to test existing theories but to develop a learning tool for colloidal topics. The tools developed were in the form of learning implementation plans (RPP), teaching materials, student activity sheets (LKPD), and assessment instruments. The validation of learning devices was carried out at Universitas Pendidikan Ganesha and implemented in class XI MIPA 2 of SMA Negeri 1 South Kuta in May 2019. The development of learning devices in this study adapted the development of Borg and Gall models modified into 5 stages of the 10 initial stages, including preliminary study, planning, initial and revised product development, initial and revised field tests, as well as major field tests and revisions. (Borg & Gall, 1989). Data collection methods used include: (1) the questionnaire method was used to obtain device validity based on expert judgment (2) the questionnaire method was used to obtain the practicality of the device based on the readability test; and (3) the questionnaire method was used to obtain practicality based on student response data on the learning process that had been carried out. The data was analyzed quantitatively by describing the score in each aspect obtained. The process of data analysis began with examining all available data from various sources after conducting research with observations, interviews, questionnaires, and documentation (Sutrisno, 2004). The way to analyze content validity by 2 experts using the Gregory formula is as follows.

$$Vi = \frac{D}{A + B + C + D}$$

Gloss:
Vi = Content validity
A = Both evaluators dissagree
B = First evaluator agree, second evaluator dissagree
C = First evaluator dissagree, second evaluator agree
D = Both evaluators agree

The content validity criteria based on the Gregory formula are shown in Table 1.

Table 1. Content Validity Criteria Based on Gregory

Range of value	Content Validity Criteria
0,8 – 1	Very high
0,6 – 0,79	High
0,4 – 0,59	Medium
0,2 – 0,39	Low
0,0 – 0,19	Very low

(Retnawati, 2015)

Consistency or appropriateness of assessment by 2 experts can use a percentage of agreement. A percentage of agreement analysis on the feasibility of learning devices can be determined using the Borich formula as follows.

Percentage of agreement:

$$= 100\%\{1 - \frac{A-B}{A+B}\}$$

Information:
A = The highest frequency of observation
B = lowest frequency of observation (Borich, 1994)

Linn (1989) states that the lower percentage of agreement used for a good rating is 0.70 or 70% according to Table 2.

Table 2. Percentage of Agreement Criteria

No.	*Percentage of agreement*	Criteria
1.	≥ 70	Good
2.	< 70	Not good

(Linn, 1989)

Practicality based on the readability test was analysed by rating 4 scale, determined the average score and converted into a table in accordance obtained as in Table 3.

Table 3. Practicality Criteria By Rating 4 Scale

Interval Score	Criteria
$3,0 < \bar{x} \leq 4,0$	Very practical
$2,0 < \bar{x} \leq 3,0$	Practical
$1,0 < \bar{x} \leq 2,0$	Not Practical
$0,0 \leq \bar{x} \leq 1,0$	Very not practical

(Retnawati, 2015)

Information:
$\bar{x}$ = average practicality score of the product

$$\bar{x} = \frac{\text{The total score of all items}}{\text{The number of items}}$$

Data on students' responses were analyzed based on a 5-scale assessment set on the questionnaire given, then analyzed to determine the average score which was then converted into table form according to the categories obtained as in Table 4.

Table 4. Product Practicality Criteria in Terms of Student Responses after Learning on A Scale of 5

Interval score	Criteria
$4{,}0 < \bar{x} \leq 5{,}0$	Very practical
$3{,}0 < \bar{x} \leq 4{,}0$	Practical
$2{,}0 < \bar{x} \leq 3{,}0$	Medium
$1{,}0 < \bar{x} \leq 2{,}0$	Not Practical
$0{,}0 \leq \bar{x} \leq 1{,}0$	Very not practical

(Retnawati, 2015)

Information:

$\bar{x}$ = average practicality score of the product

$$\bar{x} = \frac{\text{The total score of all items}}{\text{The number of items}}$$

RESULTS AND DISCUSSION

Product validity is viewed from content validity and percentage of agreement. All products are validated by 2 experts with the results shown in Table 5.

Table 5. Results of Validity of Learning Tool Content

Number	Device	Content Validity		Percentage of Agreement	
		Score	Criteria	Score	Criteria
1.	RPP	1,00	Very Valid	95,65%	Good
2.	Teaching materials	0,80	Very Valid	91,89%	Good
3.	LKPD	0,88	Very Valid	87,72%.	Good
4.	Assessment instrument	0,97	Very Valid	90,72%	Good

As a whole the learning device produced is in the form of RPP, LKPD, material text and assessment instruments having validity of 0.8-1 with very valid categories. This shows that the device developed has been very valid in terms of content and is feasible to continue. The percentage of agreement of each device based on the similarity of opinion of the expert team is also categorized as good because it has a value above 0.75 or 75%. This shows that the similarity of valuation instruments between the two experts has good criteria.

The practicality of the developed learning device is divided into two stages, namely practicality based on the readability test and practicality after the learning device developed is tested to students in the initial field test and main field test by distributing questionnaires.

The practicality test based on the readability of the learning device developed involves 2 high school teachers and 9 students of class XII specialization for MIPA in South Kuta 1 Public High School. Students only carry out practicality tests based on the readability of the LKPD, teaching materials, and assessment instruments, while the teacher carries out practical tests based on the readability of the RPP, LKPD, teaching materials, and assessment instruments. The practicality test results of the learning device in terms of readability by 2 high school chemistry teachers, the results are shown in Table 6.

Table 6. The Practicality of The Learning Device Based on The Readability Test

Learning device	Score	Criteria
RPP	3,78	Very practical
Teaching materials	3,83	Very practical
LKPD	3,68	Very practical
Assessmet instruments	3,64	Very practical

The results of the response questionnaire of students in the initial field trials of learning with the STEM-PjBL model in full are shown in Appendix 4.a. But based on the classification of aspects in assessing the teaching and learning process according to Sudjana (2002) shown in Table 4.13.

Based on students' responses given questionnaire, the average practicality value obtained is 4.59 with a very practical category (the criteria are in table 3.12) shown in Appendix 4.b.

Based on the responses of the students given questionnaire, the average practicality value obtained is 4.24 with a very practical category (the criteria are in Table 3.12) shown in Appendix 4.c.

The practicality of the learning devices developed starts from the readability test of the learning device (lesson plan, text material, LKPD, assessment instrument) which is assessed by 2 chemistry teachers (including lesson plans, teaching materials, LKPD, and assessment instruments) and 9 XII MIPA students (covering the text of the material, LKPD, and Assessment Instrument). The practicality of learning devices is very important to know before being applied in the classroom. Practical learning tools will be able to be used in learning and can be implemented well (Hala et al. 2015).

The practicality test results of the lesson plan in terms of readability assessed by 2 high school chemistry teachers are classified as very practical. The practicality test results of LKPD, teaching materials, and learning outcomes assessment instruments in terms of readability assessed by 2 high school chemistry teachers and 9 students are also classified as very practical. The points that were assessed were almost all obtained maximum results of 4, which indicated the very practical RPP, LKPD, teaching materials, and assessment instruments developed by researchers.

The initial field trials in class XI MIPA 2 and the main field tests in class XI MIPA 1, XI MIPA 4, and XI MIPA 6 SMA Negeri 1 South Kuta provided results from the practicality of the questionnaire responses of students. Practical side seen from the questionnaire contents by students, it was found that all students were very motivated in learning chemistry using STEM-PjBL. Students also state that learning with the STEM-PjBL model increases literacy, improves 4C (critical, creativity, communication, collaboration), is able to make students remember and understand the material and have a longer memory for the material provided.

Students feel that with the STEM-PjBL learning model, information obtained from the results of constructing their own knowledge makes them able to remember the old knowledge. All students stated that with the learning of the STEM-PjBL model the atmosphere became more interesting, children's creativity developed, smooth group discussion, practical activities were very active, so there was no statement of being bored in learning chemistry using the STEM-PjBL model. This is in line with the research of Afriana, et al. (2016), which states that almost all students expressed pleasure with STEM-PjBL learning and obtained very memorable experiences, so that motivation and interest in learning were very high. In addition, students experienced a significant increase in terms of the literacy carried out by students.

In general, the learning device developed has been in a very practical category with a practical value of 4.59 in the initial field test and a practical value of 4.24 in the main field test.

CONCLUSION

Based on the results and discussion of the research presented earlier, conclusions can be drawn, namely (1) The results of the validation test of learning devices based on the assessment of 2 experts include content validity and percentage of agreement. Content validity from the score range 0-1 with categories from very invalid to very valid, obtaining highly valid RPP results with a value of 1, the validity of the contents of the LKPD is very valid with a value of 0.875, the validity of the content of the material is very valid with a value of 0.80, and the validity of the content of the learning outcome assessment instrument is very valid with a value of 0.97. Percentage of agreement value from RPP is 95.65% good category, LKPD is 87.72% good category, material text is 91.89% good category, instrument valuation is 90.72 good category. Thus, learning devices developed with the STEM-PjBL model are classified as very valid in terms of content validity and percentage of agreement. (2) Practicality in terms of the readability and response of students after the learning process with the readability test value from a score range of 0 - 4, RPP obtained a score of 3.78 (very practical category), LKPD of 3.68 (very practical category), material text is 3.83 (very practical category), and assessment instrument is 3.64 (very practical category). Practicality based on the learning process response from a score range of 0-5, the initial field test stage obtained a score of 4.59 (very practical category) and the main field test was 4.24 (very practical category). Thus the learning device developed with the STEM-PjBL model is classified as very practical in terms of the readability and response of students.

Based on the results of the research that has been done, the suggestions that can be given are (1) Learning tools developed are limited to the subject of the consolidation, it is hoped that the next researcher will conduct similar research on different topics. (2) Learning tools with the STEM-PjBL model can be applied and used by teachers and students in the learning process.

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