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DEVELOPMENT OF AN INSTRUMENT TOOL ASSESSMENT FOR INTEGRATED STEM PROJECT-BASED CHEMISTRY LEARNING

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Abstract

Developing a learning model requires a design in accordance with the analysis of student needs and the applicable curriculum. The learning tool design consists of: RPP, LKPD, learning media including PPT and innovative learning videos. Before use, the learning device is first validated using the instrument that has been designed. The aim of the research is to determine the validity and reliability of the learning tool assessment instruments that have been designed before being tested on users, in this case teachers and students. The research method uses the ADDIE approach, for the validity test the CVI (content validity index) value is used, while the reliability test uses Cronbach's Alpha. The learning device assessment instrument was assessed by five validators. The research results show that the CVI value of the questionnaire validation assessment instrument is 1) RPP = 0.827; 2) LKPD=0.831; 3) Video=0.831; and 4) PPT=0.822 is in the high validity category. Meanwhile, for reliability, the average Cronbach's Alpha value obtained from each assessment instrument is 0.709 > 0.6, which is classified as reliable. For the learning tool assessment instrument in the form of lesson plans, the average value of CVI was 0.821 and LKPD was 0.815, which is in the high validity category, while the average value of CVI Video was 0.781 and PPT was 0.80, which was categorized as medium validity. Overall, the learning tool assessment instrument assessment questionnaire is valid and can be used as a research measuring tool.

Keywords: Validity, reliability, instrument, STEM

1 INTRODUCTION

In the development of the 21st century, there are many challenges that will be faced, especially in the world of education. One of them is the rapid development of technology. Openness of information and knowledge is very easy to obtain and collect in this era. Therefore, the concept of learning must be packaged so that it can build the skills needed by 21st century students, namely: learning and innovation skills, technology and information media skills as well as life and career skills [1]. The learning developed must be able to contribute to the development and ability of cooperation, problem solving, creativity and innovation which have the potential to support the economy. STEM-based learning is one solution in answering current educational challenges. Science, Technology, Engineering and Mathematics (STEM) is a learning approach that uses an inter-science approach where the application is carried out using problem-based active learning. In the STEM approach, teachers through the topics discussed connect science and technology through engineering techniques. The STEM approach can build a connection between what is learned and real life [2], [3], [4].

Innovation in learning will have a positive impact on students' learning activities, high-level thinking abilities and learning outcomes. Innovation in learning has also proven effective for improving learning activities, facilitating students' cognitive development and providing a pleasant learning environment [5]. The availability of innovative learning resources equipped with projects is able to guide students to learn organic chemistry in a more enjoyable environment, facilitate students to create projects so that learning becomes active and meaningful and the chemical material studied is remembered longer and of course can improve student achievement [6].

Project-based learning can be used to facilitate STEM learning in a way that aligns with real-world practices. Projects have long been recognized as an effective constructivist teaching approach that actively engages learners in inquiry-based processes around authentic questions and tasks. Learner-centered teaching, sometimes also referred to as learner-centered learning, allows students more flexibility to explore their creativity. Through a learner-centered form of teaching, learner interest drives the material and activities, learners are independent, have increased responsibility and accountability for their own learning and are involved in active learning [7]. One of the chemistry learning materials that is very close to everyday life is electrochemistry material which is taught in class XII of high school.

Developing a learning model requires a design in accordance with the analysis of student needs and the applicable curriculum. In designing the learning model design, learning tools such as learning implementation plans (RPP), Student Worksheets (LKPD), learning media including PPT and innovative learning videos are first prepared. Before use, the learning tool must first be validated against the instrument that has been designed. The validity test is used to show the extent to which it is used to measure what will be measured [8]. Apart from validity testing, the designed instrument must also be tested for reliability. Reliability shows that the information used in research to obtain the information used can be trusted as a data collection tool and is able to reveal true information [9]. Therefore, STEM integrated project learning tools in high school chemistry subjects must meet validity and reliability tests before being used by users.

2 METHODOLOGY

2.1 Population and Sample

This research involved high school chemistry teachers in Southwest Aceh district. The sample in this research were senior Chemistry Teachers who had more than 10 years of consecutive experience teaching Chemistry and were taken as expert validators totaling 5 people. The learning tools that were tested for validity and reliability were class XII high school redox and electrochemistry material, including: RPP, LKPD, learning videos and PPT.

2.2 Research Procedures

This research uses the ADDIE approach in developing a STEM integrated project learning model in high school chemistry teaching. The model development design requires an instrument as a research measuring tool. Instruments that meet validity standards and reliability standards can be used as measuring tools for further research.

The questionnaire validation instrument includes 11 indicators which are assessed on a scale of 5 for each RPP, LKPD, Video and PPT learning tool. Furthermore, the RPP validation instrument consists of 8 aspects including: 1) identity, 2) formulation, objectives and indicators, 3) selection of material, 4) selection of approach, 5) planning learning activities, 6) selection of learning resources, 7) preparing assessments and 8) language with 19 indicators. The LKPD validation instrument consists of 3 aspects, namely: 1) Material Suitability, 2) Appearance and 3) Language, with 20 indicators. The video validation instrument includes aspects: video content and appearance with 16 indicators. The PPT instrument consists of 1) learning scenarios, 2) media displays, 3) time allocation, 4) material delivery and 5) illustrations with 13 indicators.

Instrument validation questionnaires and learning instruments were given to 5 validators and then the results obtained were analyzed for the validity of the devices that had been designed. The results of the validity test are input for the further research stage.

2.3 Data Analysis

The assessments of the five validators are tabulated and calculated using Aiken V for each indicator and statement using the formula:

$$CVI = \frac{\Sigma s}{n(c-1)}$$

Information:
CVI = Content Validation Index
∑s = total score set by the validator minus the low score (s=r-1)
n = Number of validators
c = number of categories/scales chosen by the validator

Based on the results of the CVI calculation, a statement or indicator can be categorized based on its index as presented in Table 1.

***Table 1**. CVI calculation index*

Index	Category
CVI < 0.4	Low validity
0.4 ≤ CVI ≤ 0.8	Medium validity
CVI > 0.8	High validity

Reliability testing is carried out using internal consistency reliability (Cronbach's alpha) with the formula:

$$r_{ac} = \left(\frac{k}{k-1}\right)(1 - \frac{\Sigma_{\sigma_b^2}}{\sigma_t^2})$$

Information:
r_{ac} = Instrument reliability
k = number of questions
$\Sigma_{\sigma_b^2}$ = Number of item variants
σ_t^2 = Total number of variants

Decision making is based on if the Cronbach Alpha value is > 0.6 then the data is reliable, but if the Cronbach Alpha value is < 0.6 then it is not reliable [10].

3 RESULTS

Validity and reliability tests are based on assessments from five validators on questionnaires for learning tools and learning instruments including RPP, LKPD, Video and PPT. Instrument item validity is used to determine the support of an item for the total score. To test the validity of each instrument item, the scores on the instrument item in question are correlated with the total score. An item will have high validity if the score has great support for the total score. The support for each item is expressed in correlation form so that to obtain the validity of an item a correlation formula is used. Meanwhile, reliability refers to an understanding that an instrument is reliable enough to be used as a data collection tool because the instrument is good.

3.1 Validity Test and Reliability Test of the Questionnaire Instrument Assessment for Learning Tools

Validity test and reliability test of learning tools on the assessment of instrument questionnaires and chemistry learning tool instruments by validators. The following are the results of the analysis of the validity and reliability tests of class XII high school chemistry learning tools.

***Table 2.** Results of validity test analysis of the learning tool instrument questionnaire assessment*

No	Learning Media	CVI value	Criteria
1	RPP	0.827	High validity
2	LKPD	0.831	High validity
3	Video	0.813	High validity

4	PPT	0.822	High validity
Average		0.823	High validity

The learning tool questionnaire assessment instrument that is assessed includes aspects of clarity, accuracy of content, relevance, content validity, no bias and accuracy of the language used in detail in 11 indicators that must be assessed. Each CVI value for assessing the learning tools developed can be seen in Table 2. The average CVI value obtained was 0.823 based on the index category, which is classified as high validity, which means that the learning tool instrument is valid. The reliability value of the learning tool questionnaire assessment instrument can be seen in Table 3.

Table 3. *Reliability test analysis results for the learning device instrument questionnaire assessment*

No	Learning Media	Alpha Cronbach's value	Criteria
1	RPP	0.684	Reliable
2	LKPD	0.733	Reliable
3	Video	0.677	Reliable
4	PPT	0.742	Reliable
Average		0.709	Reliable

The Cronbach's Alpha value from Table 2 for the RPP, LKPD, Video and PPT learning tool questionnaire instruments has an average value of 0.709 > 0.6, which means that the learning tool questionnaire instrument developed is reliable. So that the learning tool questionnaire instrument can be trusted to collect data on the aspects studied.

3.2 Validity Test of the Learning Tool assessment instrument

The results of the assessment analysis for learning tools from five expert validators on lesson plans developed in the STEM integrated project learning model are in Table 4.

Table 4. *Results of RPP validation test analysis*

No	Aspects	Indicator	Analysis result			Criteria
			∑ S	(N(c-1)	CVI	
1	Identity	A	16	20	0.80	Medium validity
		B	16	20	0.80	Medium validity
2	Formulation, objectives and learning indicators	A	18	20	0.90	High validity
		B	16	20	0.80	Medium validity
		C	17	20	0.85	High validity
3	Material selection	A	18	20	0.90	High validity
		B	17	20	0.85	High validity
		C	17	20	0.85	High validity
4	Selection of learning approaches	A	15	20	0.75	Medium validity
		B	15	20	0.75	Medium validity
5	Planning learning activities	A	17	20	0.85	High validity
		B	16	20	0.80	Medium validity
6	Selection of learning resources	A	16	20	0.80	Medium validity
		B	18	20	0.90	High validity
7	Drawing up an assessment	A	18	20	0.90	High validity
		B	16	20	0.90	Medium validity

8	Language	A	15	20	0.75	Medium validity
		B	16	20	0.80	Medium validity
		C	15	20	0.75	Medium validity
Average					0.82	High validity

Based on the data in Table 3, it can be seen that the average CVI value for the validity of the RPP is 0.821, which is in the high category, however, there are several aspects of the assessment that are in the medium category. However, overall the RPP developed was declared valid. The validity test of the Student Worksheet (LKPD) can be seen in Table 5 below.

Table 5. *Result of LKPD Validity Test Analysis*

No	Aspect	Indicator	Analysis result			Criteria
			∑ S	(N(c-1)	CVI	
1	Material Feasibility	A	16	20	0.80	Medium validity
		B	16	20	0.80	Medium validity
		c1	18	20	0.90	High validity
		c2	16	20	0.80	Medium validity
		c3	17	20	0.85	High validity
		c4	18	20	0.90	High validity
		c5	17	20	0.85	High validity
		D	17	20	0.85	High validity
		E	15	20	0.75	Medium validity
		F	15	20	0.75	Medium validity
2	Appearance	A	17	20	0.85	High validity
		B	16	20	0.80	Medium validity
		C	16	20	0.80	Medium validity
		D	17	20	0.85	High validity
		E	17	20	0.85	High validity
		F	16	20	0.80	Medium validity
3	Language	A	15	20	0.75	Medium validity
		B	16	20	0.80	Medium validity
		C	16	20	0.80	Medium validity
		D	15	20	0.75	Medium validity
Average					0.81	High validity

According to Table 5, it can be seen that the appropriateness of the material contained in the LKPD for developing STEM integrated project learning is in the medium and high categories, while for language it is in the medium category. However, overall the average CVI value for LKPD is 0.815 which is in the high validity category.

Learning resources developed in research into the development of integrated STEM project learning models include innovative learning videos and PPTs for electrochemical material. Analysis of the validity values of video and PPT can be seen in Table 6 and Table 7 respectively.

Table 6. *Results of validation analysis of learning video instruments*

No	Aspect	Indicator	Analysis result			Criteria
			∑ S	(N(c-1)	CVI	
1	Video Contents	1	16	20	0.80	Medium validity
		2	15	20	0.75	Medium validity
		3	17	20	0.85	High validity
		4	15	20	0.75	Medium validity
		5	17	20	0.85	High validity
		6	14	20	0.70	Medium validity
		7	15	20	0.75	Medium validity
		8	17	20	0.85	High validity
		9	14	20	0.70	Medium validity
		10	15	20	0.75	Medium validity
2	Appearance	11	16	20	0.80	Medium validity
		12	15	20	0.75	Medium validity
		13	16	20	0.80	Medium validity
		14	16	20	0.80	High validity
		15	15	20	0.75	Medium validity
		16	17	20	0.85	High validity
Average					0.78	Medium validity

In the learning video that was developed, the video content validity value was based on 10 indicators assessed by the validator and in terms of appearance from 6 indicators, where the average CVI value was in the medium category. Learning videos are one of the important learning resources to be developed in the digital era to increase students' motivation in learning so that learning seems more real and easier for students to understand.

Table 7. *Results of validity analysis of the PPT instrument*

No	Aspect	Indicator	Analysis Result			Criteria
			∑ S	(N(c-1)	CVI	
1	Learning scenario	1	15	20	0.75	Medium validity
		2	15	20	0.75	Medium validity
		3	17	20	0.85	High Validity
		4	15	20	0.75	Medium validity
		5	17	20	0.85	High Validity
		6	15	20	0.75	Medium validity
		7	16	20	0.80	Medium validity
2	Media Display	8	17	20	0.85	High Validity
		9	14	20	0.70	Medium validity
3	Time Allocation	10	17	20	0.85	High Validity
4	Content material	11	16	20	0.80	Medium validity
		12	16	20	0.80	Medium validity
5	Illustration	13	18	20	0.90	High Validity

Average	0.80	Medium validity

Other learning resources developed in STEM integrated project learning are PPT or power points. There are five aspects of assessment, namely learning scenarios, media display, time allocation and delivery of material as well as illustrations. The average CVI value is 0.80, which is in the medium validity category.

4 CONCLUSIONS

The development of an integrated STEM project learning model in chemistry teaching has produced learning tools including lesson plans, worksheet, videos and PPT which is then tested for validity and reliability before being used as a research measuring tool. Validation test results using V Aiken with an average CVI value for the learning instrument assessment questionnaire of 0.823 with a high validity category. The reliability test uses Cronbach's Alpha with an average value of the learning tool questionnaire instrument of 0.709 > 0.6 which is classified as reliable. For the learning assessment instrument in the form of lesson plans, the average CVI value was 0.821 and the LKPD was 0.815, which was in the high validity category, while the average CVI video value was 0.781 and PPT was 0.80, which was categorized as valid and suitable for use as a research measuring tool.

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