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E-UKBM Ethno-STEM: The Development of Independent Learning Activities to Train Students' Critical Thinking Skills in Pressure Topics

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Abstract

This study aims to determine the effectiveness, feasibility, and influence of the Ethno-STEM Independent Learning Activity Unit (UKBM) in improving students' critical thinking skills. This type of research is R&D with the ADDIE type. The research sample used a purposive sampling technique in small-scale and large-scale trials at one of the private junior high schools in Salatiga City. The results of the study show that e-UKBM Ethno-STEM 1) has the characteristics of implementing an ethnoscience aspect that links scientific knowledge with local wisdom, studying science through local wisdom in a balanced way, guided by the Merdeka Curriculum and the 2013 Curriculum by using a scientific approach; 2) is suitable for use in science learning on substance stress; 3) can improve critical thinking skills with an N-Gain value of 72.27% in the high category; 4) has an effect on critical thinking skills with a t-count of 10.87. Based on the results of this study, it can be concluded that e-UKBM Ethno-STEM is appropriate to be used to improve student's critical thinking skills in substance stress study materials.

Keywords: critical thinking, independent learning activity unit (UKBM), STEM integration

INTRODUCTION

Education is becoming increasingly important to ensure students have the skills to learn and innovate as well as complex thinking and communication skills. (Arifin & Ismail 2020). The learning carried out by the teacher must be directed at the 21st Century learning with the following characteristics: 1) student learning-centered; 2) students are taught to work together; 3) learning materials related to everyday life problems; 4) learning must enable students to connect with everyday life (Widana et al. 2019). Education in Indonesia, including junior high schools, produces quality human resources that can respond to the times' challenges. Education requires teachers to adapt the new knowledge to ensure students have 21st Century skills (Hock & Muhamad 2019).

One of the skills needed is the ability to think critically. Improving and cultivating critical thinking skills is necessary to support 21st Century learning (Apak et al. 2021). Today, many teachers still ignore the development of students' creativity and critical thinking in the learning process (Kettler et al. 2018). The 21st Century learning characteristics include: 1) critical thinking and problem-solving; 2) creativity and innovation; 3) communication; and 4) collaboration. (Astuti et al. 2019). The results of previous research indicate that the level of critical thinking of students integrated with the local potential of Eremerasa nature tourism is in a low category (Suryani et al. 2020).

According to Ennis, indicators of critical thinking skills include: 1) formulating the core of the problem; 2) establishing the facts needed to solve the problem; 3) choosing logical, relevant, and accurate arguments; 4) recognizing prejudice from different perspectives; and 5) determine the consequences of a statement made as a decision (Sulistyowarni et al. 2019). Current learning is more emphasized on students who are more interested in finding out, not constantly told. Learners are more active in training students' critical thinking skills (Laili et al. 2019). STEM education in recent years has become a field of increasing interest in education (Lummis et al. 2021).

STEM learning teaches students how concepts, and principles of Science, Technology, Engineering, and Mathematics are integrated to design products, processes, and systems that benefit human life (Sudiarta & Widana 2019). PBLPOE and PBL can generally improve students' critical thinking skills (Fitriani 2019). Problems in life can be integrated with local wisdom or the local culture around them, and this learning is called ethnoscience integration in STEM or the learning of the Ethno-STEM approach (Ariyatun 2021).

An Ethno-STEM approach rooted in local culture will give birth to interesting learning (Sudarmin et al. 2020). Obstacles in carrying out science learning, namely the teacher's delivery of material, are still general and not specific (Risdyanti et al. 2019). Schools need to provide teachers who can develop STEM-based learning and its integration (Rukoyah et al. 2020). The study results show that STEM project-based learning can be an alternative strategy to increase students' motivation toward learning science (Salikha et al. 2021). The application of a comprehensive Ethno-STEM approach can be easily applied throughout learning. Teachers are guided by the project-based Ethno-STEM learning model (Toto 2019).

The results of the learning analysis in several secondary schools show that there are still several obstacles in the learning process, including limited learning resources for students and not approaching Ethno-STEM (Sudarmin & Nikmatul 2022), low understanding of STEM, lack of facilities and limited time provided. in the learning schedule (Diana et al. 2021). Various scientific learning media such as interactive books, e-worksheets, animated videos, stimulation and virtual labs can be developed from local cultural wisdom (Sari et al. 2020). Ethno-STEM integration will be more effective if it is equipped with several strategic approaches in its implementation (Anjarsari et al. 2020).

Natural Science is a science related to facts, processes, theories, concepts, and generalizations (Wiwin et al. 2020). The discussion of substance pressure is closely related to everyday life. However, many students still do not understand the concept of substance pressure, including those related to hydrostatic pressure, Pascal's law, and Archimedes' law (Widana et al. 2019). Students tend to have difficulty learning science in the physics branch and rely on memorizing mathematical formulas, not understanding scientific concepts (Hidayati & Sinaga 2019). Students need science learning innovations that can be accompanied by direct application (Lestari et al. 2021). Teachers must be able to convey a complete learning unit, which is called the Independent Learning Activity Unit (UKBM) (Majid & Linuwih 2019).

The Independent Learning Activity Unit (UKBM) is a learning medium that regulates knowledge, technical limits, and evaluation methods rationally and interestingly to help improve students' critical, creative, collaborative, and communicative thinking skills, reading culture, and character building (Kurnia et al. 2022). The UKBM that has been developed so far has not been oriented towards Ethno-STEM and is still in the paper stage and has not been adopted into digital media such as websites and content on Android (Rochintaniawati et al. 2019).

Utilizing UKBM digitalization is very important in the modern era because it will enable students to learn easily anywhere and anytime (Nurramadhani et al. 2021). Referring to these problems, the existence of e-UKBM Science with an Ethno-STEM approach to studying substance stress material is expected to facilitate students in learning to achieve the expected competencies.

METHODS

This study developed an e-UKBM based on Ethno-STEM in science subjects at the VIII grade junior high school level. The method used in this study is the Research and Development (R&D) method of the ADDIE type (Analysis, Design, Development, Implementation, Evaluation). This study uses the ADDIE development procedure with the cycle described in FIGURE 1.

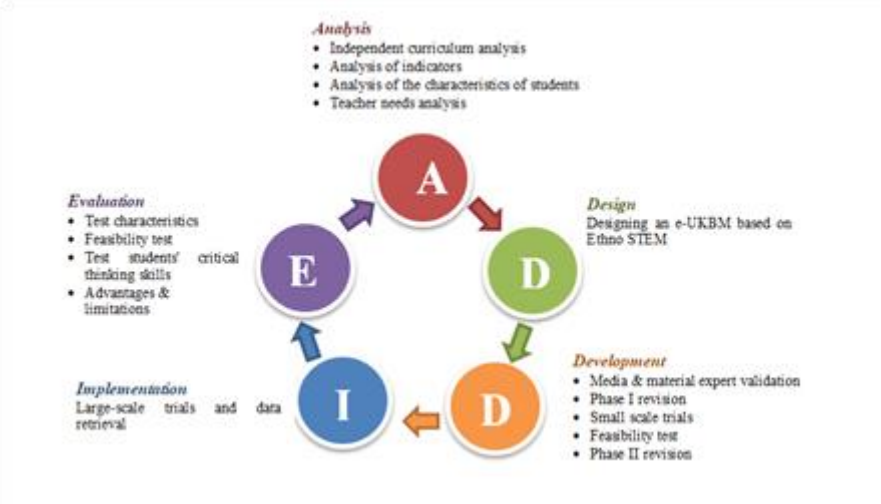

FIGURE 1. ADIE Development Model

This study used two data collection methods, namely the interview method, the questionnaire method, and the test method. This research was conducted at Dharma Lestari Middle School, located in Salatiga City, Central Java. The population of this research is class VIII students in the academic year 2022/2023. The limited trial sample was carried out using a sample of 6 students consisting of 2 students with low abilities, 2 with moderate abilities, and 2 with high abilities. The wide trial was carried out using a sample of one class, which consisted of 30 students from 173 students of SMP Dharma Lestari class VIII, with the selection of a purposive random type of sample.

This study used interview sheets for teacher and student needs analysis, UKBM Ethno-STEM eligibility questionnaires for experts, and cognitive assessment sheets. The technique of analyzing the feasibility instrument uses a construct validity test with expert judgment techniques. Lecturers and teachers carry out the validation technique as experts. The scoring guide uses the scoring technique used by Mardapi (2008).

The data obtained from this study include quantitative data from the results of the e-UKBM feasibility questionnaire and qualitative data from product improvement suggestions. The normality test of the data in this study used the Kolmogorov-Smirnov test to determine whether the data were normally distributed or not. The improvement of students' critical thinking was tested using the N-Gain enhancement test. The average increase in student learning outcomes from one cycle to the next is analyzed using normalized gain (Normalized Gain). This increase is taken from the pretest and posttest scores obtained by students. The effect of e-UKBM on students' critical thinking skills was measured using a t-test by comparing tcount with ttable—the significance of the t-test for mastery learning according to (Sugiyono 2013: 250). The research implementation procedure plan is shown in FIGURE 2.

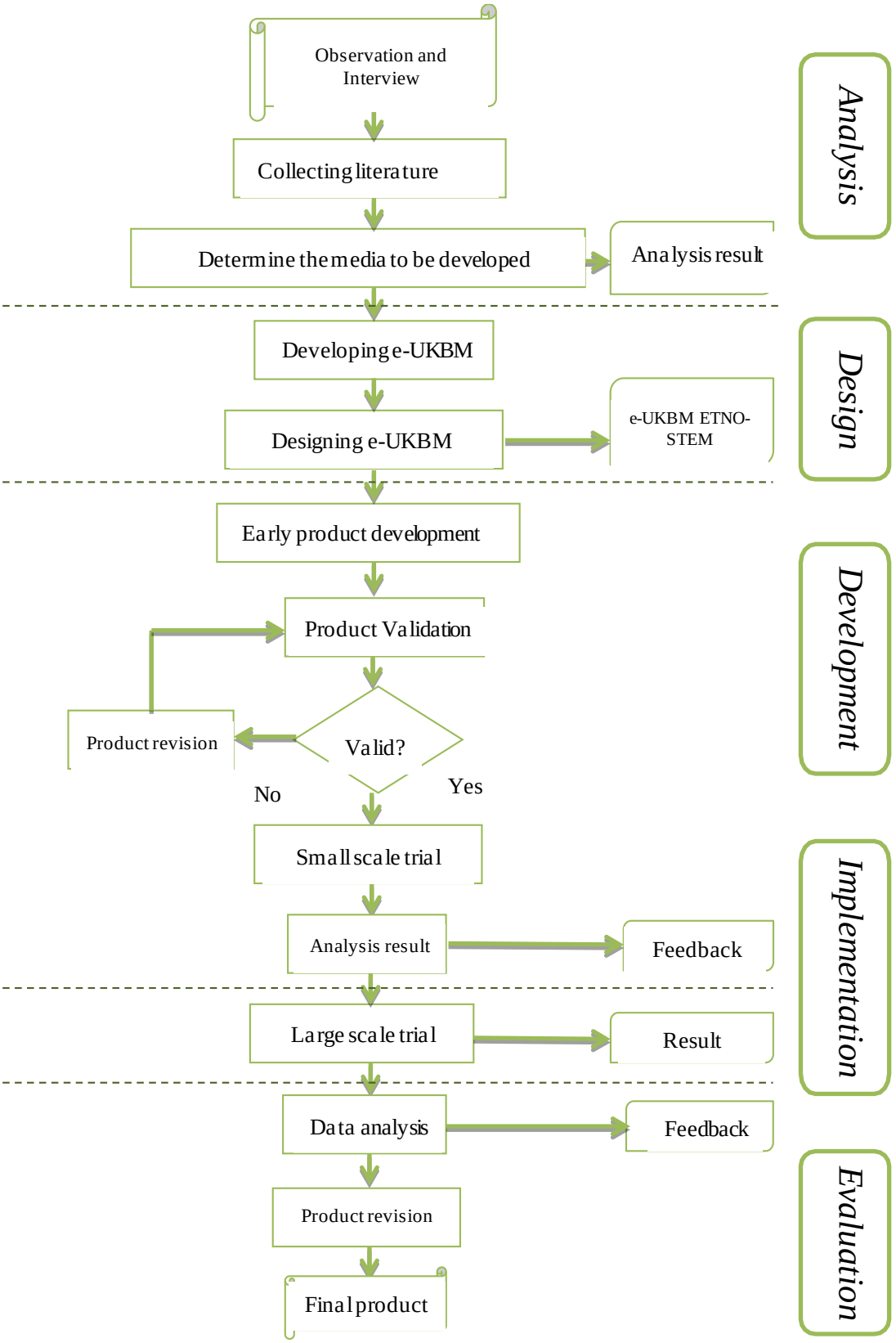

FIGURE 2. Ethno-STEM e-UKBM Development Design

RESULTS AND DISCUSSION

Based on the results of interviews with teachers, the e-UKBM Ethno-STEM was developed according to the needs of teachers and students. The teacher needs analysis instrument is used to find out the obstacles experienced by teachers in implementing their teaching and learning activities to provide solutions in this study. Instruments for student needs are used to determine the appropriate curriculum, materials, indicators, and learning methods, which can then be used as a research reference.

The e-UKBM Ethno-STEM that had been compiled was then tested by expert validators, 1 lecturer at the State University of Semarang, 1 lecturer at the Satya Wacana Christian University and 3 science teachers for SMP in Salatiga City. The recapitulation of the results of the e-UKBM Ethno-STEM validation is shown in TABLE 1.

TABLE 1. Recapitulation of e-UKBM Ethno-STEM Validation Results

Component	Average score	Percentage (%)	Information
Content Eligibility Component	3.67	91.75	Worthy
Language Component	3.70	92.50	Very Worthy
Components of Serving	3.60	90.00	Worthy
Ethno-STEM Component	3.72	93.00	Very Worthy
Appearance	3.55	88.75	Worthy
Use of Letters	3.60	90.00	Worthy
Completeness	3.69	92.25	Very Worthy
Average	**3.65**	**91.18**	**Worthy**

Based on the recapitulation of the final validation results shown in TABLE 1, it can be seen that the average validation score is 3.65 points with a decent score criterion. The results of this recapitulation indicate that the e-UKBM Ethno-STEM is feasible to use. The final conclusion obtained from the online form shows that 40% suggest that the Etno-STEM e-UKBM can be used with minor revisions, and 60% suggest that the e-UKBM Ethno-STEM can be used without revision.

Based on the teacher's response to the e-UKBM Ethno-STEM after the trial, an average score of 3.94 was obtained in the very feasible category. The response statement is adjusted to the validation test criteria with the required changes. The Dharma Lestari Junior High School teacher stated that the e-UKBM Ethno-STEM was feasible to be used at the SMP/MTs level equivalent to class VIII. It is considered to be able to raise students' motivation in learning science and its relationship with local wisdom and can invite students to improve their critical thinking skills.

Based on the students' responses to the e-UKBM Ethno-STEM after the trial, the percentage of eligibility was 97.58%, with a very feasible category. Students provide a statement that it is appropriate for use at the SMP/MTs level and equivalent in accordance with the related material. It is also considered interesting and can motivate students to learn science and its relation to local wisdom.

The e-UKBM Ethno-STEM was declared suitable for use after a small-scale trial was carried out, so a large-scale trial could be carried out on 15 class VIII SMP Dharma Lestari students. The results of the evaluation on large-scale trials are shown in TABLE 2.

TABLE 2. Evaluation Results of Large-Scale Trials

Pretest	Average	54.42
	Median	55.00
	Variance	20.95
	Standard deviation	4.58
	Minimum	47.50
	Maksimum	61.25
Posttest	Average	84.75
	Median	81.25
	Variance	67.01
	Standard deviation	8.19
	Minimum	72.50
	Maximum	95.00

The results of the pretest and posttest normality tests can be seen in TABLE 3 and TABLE 4. The normality test using the Microsoft Exel program.

TABLE 3. Normality Test on Small Scale Test

	Kolmogorov-Smirnov	**Result**	**Conclusion**
Pretest	0.28	D(0.28) < K(0.52)	The population of students' scores is normally distributed
Posttest	0.15	D(0.15) < K(0.52)	

TABLE 4. Normality Test on Large-Scale Test

	Kolmogorov-Smirnov	**Result**	**Conclusion**
Pretest	0.14	D(0.14) < K(0.34)	The population of students' scores is normally distributed
Posttest	0.20	D(0.20) < K(0.34)	

TABLE 3 shows the significance of the Kolmologrof-Smirnov Test of Normality for the pretest data D(0.28) < K(0.52) and the posttest D(0.15) < K(0.52). TABLE 4 shows the significance of the Kolmologrof-Smirnov Test of Normality for the pretest data D(0.14) < K(0.34) and the posttest D(0.20) < K(0.34). The significance value of the normality test is greater than 0.05, so it can be concluded from the pretest and posttest data that the class is normally distributed.

The N-Gain test was calculated using the Microsoft Excel program. The improvement of students' critical thinking skills was tested using the N-Gain test as shown in TABLE 5.

TABLE 5. N-Gain Test of Critical Thinking Ability

	Average Pretest Score	**Average Posttest Score**	**N-Gain (%)**
Small Scale Test	54.79	87.29	72.27
Large Scale Test	54.42	84.75	65.66
Conclusion	e-UKBM Ethno-STEM is quite effectively used to improve students' critical thinking skills		

TABLE 5 shows the average value of students' critical thinking skills in the trial class rose significantly. The test class N-Gain value is in the N-Gain range > 0.7, where the increase in students' critical thinking skills is included in the high category according to Hake's (1999) interpretation. This increase shows that the e-UKBM Ethno-STEM is able to help students significantly improve their critical thinking skills.

The t-test in this study was used to determine whether the e-UKBM Ethno-STEM implementation affected students' critical thinking skills. The effect of these on students' critical thinking skills in general is shown in TABLE 6.

TABLE 6. Critical Thinking Ability t-test

	Pretest	**Posttest**
Average	54.42	84.75
Standard deviation	4.58	8.19
Variance	20.95	67.01
Dk	n_1+n_2 -2	28
Average difference	-30.33	
Variance$_1$/n_1	1.40	
Variance$_2$/n_2	4.47	
Correlation coefficient	-0.39	
2 Correlation coefficient	-0.77	
Standard deviation/akar n_1	1.18	
Standard deviation/akar n_2	2.11	
T count	-10.87	
T table	-1.70	

TABLE 6 shows that the t-count for 5% significance is 10.87, while the t-table with 15 samples and 5% significance level is 1.70. It can be seen that $t_{count} > t_{table}$, so Ho is rejected and there is an effect of giving e-UKBM Ethno-STEM on students' critical thinking skills.

The Independent Learning Activity Unit (UKBM) that has been developed so far has not been Ethno-STEM oriented and is still in the paper stage and has not been adopted into digital media such as websites and content on Android (Rochintaniawati et al. 2019). Utilization of UKBM digitization is very important in the modern era because it will allow students to learn easily anywhere and anytime (Nurramadhani et al. 2021). The main characteristics of the e-UKBM developed are self-instructional (facilitating independent learning), containing material pressure, adaptive, and use friendly (easy to use). In addition to covering learning materials, the developed e-UKBM is equipped with experimental videos, projects for applying the concept of pressure, simple experimental procedures, application of the concept of pressure of substances in everyday life, as well as evaluations that are presented in digital form so that they can be accessed via mobile phones anywhere and anytime. UKBM material pressure covers the material pressure of solids, Pascal's Law, Archimedes' Law, as well as the application of pressure in everyday life.

The addition of ethnoscience content brings students to understand the concept of science in real terms. Students can understand the concept of science through the context in their daily life. Local wisdom that has become foreign to students makes them interested in learning science in a different way than usual. The curiosity of students is increasing.

CONCLUSION

The Independent Learning Activity Unit (UKBM) is a learning medium that regulates knowledge, technical boundaries, and evaluation methods rationally and interestingly to help improve students' critical, creative, collaborative, and communicative thinking skills, reading culture and character building. The results of the study show that e-UKBM Ethno-STEM: 1) has the characteristics of implementing an ethnoscience aspect that links scientific knowledge with local wisdom, studying science through local wisdom in a balanced way, guided by the Merdeka Curriculum and the 2013 Curriculum by using a scientific approach; 2) is suitable for use in science learning on substance stress;

3) can improve critical thinking skills with an N-Gain value of 72.27% in the high category; 4) has an effect on critical thinking skills with a tcount of 10.87. Based on the results of this study, it can be concluded that e-UKBM Ethno-STEM is appropriate for improving students' critical thinking skills on substance stress study materials.

The main characteristics of the developed e-UKBM are self-instructional (facilitating independent learning), containing substance pressure material, adaptive, and user friendly (easy to use). In addition to covering learning materials, the developed e-UKBM is equipped with trial videos, pressure concept application projects, simple experimental procedures, application of the substance pressure concept in everyday life, as well as evaluations that are presented in digital form so that they can be accessed via mobile phones anywhere and anytime. UKBM on the pressure of a substance covers material on the pressure of solids, Pascal's Law, Archimedes' Law, and the application of pressure in everyday life. The developed e-UKBM implements ethnoscience aspects that link scientific knowledge with local wisdom, learns science through local wisdom in a balanced manner, guided by the Merdeka Curriculum and the 2013 Curriculum using a scientific approach, and can be used in student self-learning.

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