Application of Ethno-STEM Learning Multimedia on the Topic of Substances and Their Changes to Improve Student Learning Outcomes

Bayu Antrakusuma[1], Nurmalita Amanda Nasution[2], Meida Wulan Sari[1], Amalia Arum Permatasari[1], Khorunnisa Eka Wardani[1], Shalma Mila Zasna Kunni[1], Riana Nur Hidayah[1], Suciati[1], Bramastia[3], Febriani Sarwendah Asri Nugraheni[1], Icha Kurnia Wati[1], and Dyah Fitriana Masithoh[1]

[1]Bachelor of Science Education, Faculty of Teacher Training and Education, Sebelas Maret University, Surakarta, Indonesia
[2]Teacher Professional Program, Faculty of Teacher Training and Education, Sebelas Maret University, Surakarta, Indonesia
[3]Postgraduate Science Education, Faculty of Teacher Training and Education, Sebelas Maret University, Surakarta, Indonesia
antrakusumabayu@staff.uns.ac.id

Abstract. This study aims to improve student learning outcomes by applying Ethno-STEM learning multimedia to the topic of Substances and Their Changes. The application of Ethno-STEM multimedia involves the use of interactive media that utilizes local wisdom in the STEM (Science, Technology, Engineering, and Mathematics) learning approach and Project Based Learning (PjBL). The study was a classroom action research conducted in two cycles. The research was conducted in class 7B of SMP Negeri 27 Surakarta. The research procedure involves observing the use of Ethno-STEM learning multimedia and students, starting with the first cycle, which includes conducting a pre-test, providing learning using Ethno-STEM multimedia, and conducting the first post-test. The second cycle repeated the lesson using the Ethno-STEM multimedia and conducted the second post-test. Student learning outcomes are taken from the post-test scores for each cycle with a passing standard of 75. This cycle will continue until the students' average score reaches 75 and the number of students who pass reaches 60%. Data from the first and other cycles were then processed using Microsoft Excel. The results showed that the use of Ethno-STEM multimedia can improve student learning outcomes, with an average post-test cycle 1 score of 70.1 (36,7% of students passed) and post-test cycle 2 score of 77.5 (66,7% of students passed). The results of this study are expected to be a reference to be developed again and can be implemented in science learning by teachers and researchers.

Keywords: Science Learning Multimedia, Ethno-STEM, Learning Outcomes, Substances and Their Changes.

1 Introduction

The development of technology and science in the era of the Industrial Revolution 4.0 is very influential in the field of education. Teachers are now required to be creative to

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adapt to increasingly advanced technology, which changes the pattern of life, work, and interaction of each individual, especially students. Thus, teachers need to develop their creativity to apply technology and innovative methods in their learning [1]. According to the P21 Partnership for 21st Century Learning (2007), these skills are known as the 4Cs, namely communication, collaboration, critical thinking, and creativity.

Four C (4C) skills are currently being implemented in Indonesian Education through the Merdeka curriculum. The Merdeka Curriculum provides diversity in classroom learning, so that the content provided to students is more optimal, and the concepts can be understood in depth to strengthen competence. Teachers are given the freedom to choose learning tools that suit the needs and interests of students [3]. This is following the view of education according to Ki Hadjar Dewantara in Suparlan [4], namely, a system of among (guidance) that develops the child's natural ability to solve problems according to the broad ability to think by the guidance of pamong (educators). The expected competency in this curriculum is the formation of the Pancasila learner profile, where students are guided to solve problems found in the surrounding environment [5]. Based on this, the 4C skills implemented in the Merdeka Curriculum are actual today. Teachers need to provide learning content and projects that are tailored to the problems in the environment around students, to form Pancasila characters who are solutive to environmental problems.

One of the environmental problems can be studied in terms of science. Teachers can bring and discuss these problems in the subject of Natural Sciences (IPA) taught at Junior High School (SMP). Science is a subject that teaches about natural phenomena and finding out about natural phenomena that occur through experiments based on the scientific method [6]. Studying science is an effort to get to know everything in the environment and ourselves, and to know why and how all these things can happen, whether it is related to nature, plants, animals, and even invisible things [7]. With the right approach, science can be taught optimally to students to achieve the main objectives of learning.

One of the appropriate learning approaches in teaching science is STEM. STEM is a learning approach that integrates four disciplines (Science, Technology, Engineering, and Mathematics) to encourage critical thinking, problem-solving, and innovation needed by learners in facing the demands of 21st-century skills [8]. Learning models implemented using the STEM approach such as project-based learning, technology-based learning, and interdisciplinary learning, can have a positive impact on student achievement in science subjects [9]. The selection of the right media also affects the optimal continuity of science learning. One of them is STEM-based multimedia, where the application of multimedia can fulfill aspects of science learning [10]. Multimedia learning has the benefit of being a learning resource that can be accessed from diverse media that is packaged attractively so that it can provide positive value in learning [11].

Based on observations made at SMP Negeri 27 Surakarta, it was found that science learning in grade 7 was often not held and replaced with assignments. In addition, the teacher has never utilized technology in learning, so the class seems monotonous. The motivation of students in learning science looks still lacking which is characterized by feelings of laziness and boredom in science learning activities. In addition, students are less active in expressing opinions and questions and are

reluctant to work on problems given by the teacher. Based on the interview results, one of the science topics that are difficult to teach is Substance and its Changes, characterized by the value of student learning outcomes that are not too large compared to other topics. based on the results of document analysis, it was found that the average exam score on this topic was 55 (passing score - 75), and there were only 7 out of 30 students who had scores above 75. This is following the research Sari et. al [12] that the chapter on Substances and Their Changes is classified as difficult because it requires physical science and is abstract in nature. These problems are possible because the teacher does not utilize media that can provoke the focus of students and has not applied the right approach, model, and learning method to improve student learning outcomes. This is because good learning will integrate various media, models, and strategies to achieve the ultimate goal of providing high understanding to students [13].

Based on these problems, it is necessary to apply multimedia based on the actual approach presented through a learning model that can provoke the focus and activeness of students and adapt to the profile of Pancasila students. For this reason, researchers conducted the **Application of Ethno- STEM Learning Multimedia on the Topic of Substances and Their Changes to Improve Student Learning Outcomes**. Ethno-STEM itself is the utilization of local wisdom in learning using the STEM approach [14]. By taking problems through local wisdom, it is expected that students will more easily relate science learning through phenomena in the surrounding environment by the profile of Pancasila students who are solution agents for environmental problems. one of the appropriate learning models for the STEM approach is Project Based Learning (PjBL). This learning model is suitable because it has learning steps that can bring out science, technology, engineering, and mathematics literacy [15].

Ethno-STEM multimedia has been developed in previous research and contains Substances and their Changes material associated with the local wisdom of making eco-print batik. The content is presented through text, images, videos, online worksheets, and online whiteboards that can be accessed collaboratively between students. This is expected to provoke learning focus and motivation and can improve student learning outcomes.

2 Method

This research is Classroom Action Research. Classroom action research is research conducted by teachers to improve student learning outcomes through actions that have been carried out in several cycles [16]. This research was conducted in class 7B of SMPN 27 Surakarta with 30 students. This research was conducted in two cycles. Each cycle has stages of planning, action, observation, and reflection [16].

The applied science learning topic is Substances and their Changes. The topic is delivered using Learning Multimedia based on the STEM approach containing science topics associated with local wisdom (Ethno-STEM) with the Project Based Learning (PjBL) learning model. The data collection method used a test technique. The test technique was carried out during the application of learning by using *pre-test,*

post-test 1 (cycle 1), and *post-test 2* (cycle 2) questions. In cycle I, the *pre-test* was carried out first, then continued with core learning for two meetings and ended with *post-test 1*. If the results have not reached the target of completeness (the pass target is following the teacher's regulation, namely an average score of 75 and the number of students who pass 60%) then the second cycle is carried out, by reviewing the topic again using the same stages, then continuing with *post-test 2*. The collected data were processed with the *mean* formula using Microsoft Excel. The cycle will stop when the student's average score has reached the target.

PjBL STEM has learning steps namely reflection, research, discovery, application, and communication [15]. At the reflection stage, students through Ethno-STEM Multimedia in groups observe problems regarding textile waste pollution, then formulate problems and make hypotheses (Science). At the research stage, learners look for references about natural dyes to deal with textile waste (Science, Technology). At the discovery stage, learners make eco-print batik designs through a whiteboard on multimedia (Science, Technology, Engineering, Mathematics). At the application stage, learners make eco-print batik according to the design made earlier (Science, Technology, Engineering). At the communication stage, students present the results of the project they made (Science, Technology). The relationship between PjBL and STEM applied in learning can be seen in Table 1.

Table 1. Relationship between PjBL and STEM (Ethno-STEM).

PjBL	STEM (Ethno-STEM)
Reflection	Science
Research	Science, Technology
Discovery	Science, Technology, Engineering, Math
Application	Science, Technology, Engineering
Communication	Science, Technology

At the end of learning, post-test 1 was conducted with an essay totaling 3 questions. The following is Table 2, which is a rubric of questions that is a reference in assessing student learning outcomes. Student learning outcomes are obtained by calculating the total student score after working on the post-test question dividing by the maximum score and multiplying by 100.

Table 2. Post-test question rubrics.

No	Question indicator	Question	Answer	Score
1	Physical Changes and Chemistry	A table of physical and chemical changes is provided, it is hoped that students can fill it in the table correctly	Physics answer: ice melts, wax melts, paper tears, water boils Chemistry answer: rotting apples, coffee	1 = correct 1 2 = correct 2 3 = correct 3

			brewing, burnt wood, rusting iron	4 = correct 4 5 = correct 5 6 = correct 6 7 = correct 7 8 = correct 8
2	Change of Form Substance	A picture of changes in the state of matter is provided, it is hoped that students can fill it in correctly changes in substances that occur	Answer: 1. Freezing 2. Melting 3. Yawn 4. Condensation 5. Sublimate 6. Crystallize	1 = correct 1 2 = correct 2 3 = correct 3 4 = correct 4 5 = correct 5 6 = correct 6
3	Melting Point and Boiling Point	A graph of changes in the state of matter is provided, It is hoped that students can fill in correctly regarding the changes in the state of substances based on temperature and time	Answer: 1. Solid 2. Melt 3. Liquid 4. Yawn 5. Steam	1 = correct 1 2 = correct 2 3 = correct 3 4 = correct 4 5 = correct 5

3 Result and Discussion

The results of research on the application of Ethno-STEM Multimedia to improve student learning outcomes can be seen in cycle 1 and cycle 2. Learning in each cycle is carried out with 4 stages, namely: 1) planning, 2) action, 3) observation, and 4) reflection. In Cycle 1, the first stage begins with planning. Planning was done by designing learning, preparing student conditions, and forming heterogeneous groups.

The second stage is action, which is implementing the planned learning. Cycle 1 learning consisted of 2 meetings during 5 Lesson Hours (JP). The learning topic of Substances and their Changes is associated with the topic of local wisdom, namely making eco-print batik. The topic is delivered through Learning Multimedia based on the STEM approach with the Project Based Learning (PjBL) learning model (see Fig 1-4).

Fig. 2. Interactive animation on Ethno- STEM Multimedia.

Fig. 3. Learner worksheet on Ethno- STEM Multimedia.

Fig. 4. Making Eco-print Batik by students.

The next stage is observation, carried out by observing difficulties when carrying out actions and assessing student learning outcomes. Students' learning outcomes in cycle 1 can be seen from the average scores obtained in the pre-test and post-test 1. Cycle 1 learning outcomes can be seen in Table 3.

Table 3. Cycle 1 student learning outcomes.

Stages		Mean (learning outcomes)	Achievement (≥ 75)
Cycle 1	Pre-test	55,1	not passed
	Post-test 1	70,1	not passed

The last stage is reflection, which is to look back at the learning that has been done, and then prepare an action plan based on the results obtained. Based on the cycle 1 learning outcomes data in Table 3, the average pre-test score was 55.1 and there was an increase in the post-test 1 cycle 1 which was 70.1. The target of completeness

determined by the teacher is a score ≥ 75, and the results of post-test 1 have not yet reached completeness. It can be concluded that the learning outcomes of students in cycle 1 have not been completed. So that learning is needed in the next cycle (cycle 2).

Cycle 2 learning was carried out by applying the same 4 stages of planning, action, observation, and reflection. The activities carried out in each action in cycle 2 were almost the same as in cycle 1. However, some modifications were added and adjusted to the results of the reflection. Starting with the planning stage then followed by action. The action stage of cycle 2 was carried out by studying and reviewing the material of Substance and its Changes for 2 Lesson Hours (JP) using the same media, approach, and learning model and ending with post-test 2 which has been modified with different questions but with the same competencies.

The next stage is observation. This stage is carried out by re-observing difficulties when performing actions and assessing student learning outcomes. Student learning outcomes in cycle 2 can be seen from the average scores obtained in post-test 2 which are presented in Table 4.

Table 4. Cycle 2 student learning outcomes.

Stages		Mean (learning outcomes)	Achievement (≥ 75)
Cycle 2	Post-test 2	77,5	passed

The reflection stage in cycle 2 was carried out by looking back at the learning that had been carried out and identifying the factors that caused the increase/decrease in learning outcomes. Based on Table 4, the learning outcomes of students in cycle 2 scored 77,5 indicating that the learning was complete because it had reached the limit of completeness. Thus, there is no need for learning in the next cycle. The following is a comparison of the average learning outcomes of students in cycle 1 and cycle 2.

Table 5. Average learning outcomes of students cycle 1 and cycle 2.

Stages		Mean (learning outcomes)	Achievement (≥ 75)
Cycle 1	Pre-test	55,1	not passed
	Post-test 1	70,1	not passed
Cycle 2	Post-test 2	77,5	passed

Table 6. Number of students who passed the test.

Number of Students Who Passed the Test (out of 30 students)		
Pre-test	Post-test 1	Post-test 2
7 (23,3%)	11 (36,7%)	20 (66,7%)

Based on the data in Table 5, there is a change in the learning outcomes of students from cycle 1 to cycle 2, namely 70,1 and 77,5. Based on Table 6, there was an increase in the number of students who reached the graduation target. There are 30 students in this class. In the pre-test, only 7 students (23,3%) reached the target. In cycle 1, only 11 students (36,7%) reached the target, but an increase occurred in cycle 2, where 20 students (66,7%) reached the target. Based on these results, the learning

stopped in cycle 2, because it had reached the desired target. With the data that has been obtained, it can be concluded that this research can show a fairly good improvement in student learning outcomes with the application of Ethno-STEM Multimedia on the topic of Substances and Their Changes.

The improvement in learning outcomes is due to the utilization of concrete media, thus providing a good learning experience for students. Ethno-STEM multimedia facilitates students to read, listen, see images, discuss, and present problems presented through text, images, video, audio, and interactive animation. Based on Edgar Dale's cone in Sanjaya [18], when a medium provides problems that stimulate active thinking, learners will remember 70%. When role-playing, simulating, and doing the real thing, learners' recall increases to 90%. This is proven by research by Khoiriah et al. [19], which states that the application of science learning multimedia by providing good animation effects can produce a fairly high average cognitive score. Proper use of multimedia also has the potential to increase metacognitive scores in both learning and testing situations [20]. Ethno-STEM multimedia can be accessed through smartphones, making it in line with current technological developments. In addition, this multimedia can be used easily anytime and anywhere. According to research Widodo et al. [21], gadget-based interactive multimedia can be easily applied to learning and can also improve the science literacy of today's generation of children (Gen-Z).

The improvement in learning outcomes from cycle 1 to cycle 2 is not only influenced by good learning media but also by good learning strategies. Ethno-STEM multimedia is applied to the Project Based Learning (PjBL) STEM learning model by taking the topic of local wisdom. This learning model is based on the constructivism learning theory that directs students to be active and collaborate with other students. The constructivism approach itself is a learning theory that prioritizes creating and constructing something that has been learned. Constructive activities can encourage students to stay active to increase their intelligence [22]. This is following the research Prajoko et al [23], which states that there is a relationship between PjBL learning with a STEM approach to creativity and understanding of science learning concepts. Thus, PjBL with a STEM approach becomes interesting and effective for learning and can be an alternative learning model for teachers to understand the application of technology and engineering in the classroom [24].

The topic selection of eco-print batik is an actual local wisdom topic for students at SMP 27 Surakarta. Science learning that is associated with local culture has a significant relationship to the curriculum in Indonesia so that the younger generation does not forget their local wisdom [25]. Based on research Dewi et al. [26], Science learning that is linked to local cultural perspectives increases students' interest and understanding in learning because the learning is related to facts in the community that students have known before.

Based on this, it can be concluded that Ethno-STEM Multimedia can provide a good learning experience because it contains actual and relevant problems that can increase students' active thinking, and is presented interactively by current technological developments. In addition, Ethno-STEM Multimedia is implemented with a learning strategy that encourages students to actively collaborate to create and build on their learning experiences to increase intelligence.

Based on Table 5 and Table 6, there was only an increase in learning outcomes by 7 points (70,1 to 77,5) from cycle 1 to cycle 2 and there were still students who had not reached passing scores. The factors that cause this are low motivation to learn, and a less conducive classroom atmosphere. Researchers realize that no learning strategy suits all the characters of students, and not all students can follow the learning patterns applied. So, this shortcoming is a separate motivation for researchers to be more careful and creative in providing learning in the future.

4 Conclusions

The application of Ethno-STEM Learning Multimedia on the Topic of Substances and Their Changes can improve the learning outcomes of students in class 7B SMP Negeri 27 Surakarta. The average learning outcomes obtained in cycle 1 amounted to 70.1 (36,7% of students passed) and increased to 77.5 in cycle 2 (66,7% of students passed). Several factors cause learning outcomes to not increase significantly, namely the existence of low learning motivation, and a less conducive classroom atmosphere. It is hoped that the results of the implementation of this study can be used as a reference and can be developed again and used in science learning by teachers and further researchers.

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