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The Effects of Ethnoscience Integrated STEM E-Book Application on Student's Science Generic Skills in Chemical Equilibrium Topic

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Abstract

This study aims to know the effects of the application of ethnoscience integrated STEM e-book on learning outcomes and student's science generic skills on chemical equilibrium topic. The research method that used is experiment and the research design that used is Pretest- posttest Control Group Experiment. The sample of this research was taken by cluster random sampling technique, there are XI IPA 4 as an experimental class and XI IPA 3 as a control class. Data collection techniques are carried out with a reasonable multiple choice test to measure learning outcomes and student's science generic skills, questionnaires to find out students' responses to the e-book that used as teaching materials. Data analysis techniques that used is the average difference test, analysis of the effects between variables, and the stipulation of the determination coefficient. The research results obtained by the average cognitive learning outcomes of students in the experimental class and control class respectively 78.64 and 51.21. Analysis of the effects between variables shows a biserial coefficient is 0.90. Calculation of the determination coefficient shows the implementation of ethnoscience integrated STEM e-book accounted for 82%. While the average science generic skills of students in the experimental class and control class were 77.81 and 35.58, respectively. Analysis of the effects between variables shows a biserial coefficient is 0.97. Calculation of the determination coefficient shows that the application of ethnoscience integrated STEM e-book contributed 95%. Based on the results of the study it can be concluded that the application of ethnoscience integrated STEM e-book has an effect on learning outcomes and students' science generic skills in chemical equilibrium topic

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INTRODUCTION

21st Century Partnership Learning Framework states, there are several competencies and expertises that must be possessed by 21st century human resources, one of which is: The ability to think critically and solve problems (Ross, 2007). Critical thinking as one of the complex thinking patterns is a pattern of thinking to analyze arguments and bring up the insights on each meaning and interpretation. Critical thinking develops cohesive and logical reasoning patterns. This mindset also used to understand the assumptions and biases that underlie each position. Thus this mindset can provide a presentation model that can be trusted, concise, and convincing. So it needed the skills that can develop students' thinking skills.

Science generic skills are skills that must be achieved by students through mastery of competencies. Achieved competence depends on the component content or subject matter that received by students (Agustinaningsih et al. 2014). Chemistry learning oriented science generic skills can be done through experimentation (observation direct or indirect, symbolic language, logic obedient principle, the law of cause and effect, and concept building) and through the simulation computation (indirectly observation, language, symbolic, logic obedient principles, mathematical modeling, and concept building) (Sudarmin and Suyanti, 2012).

Wahyana (2001) said chemistry as one of the fields of Natural Sciences that provides a variety of learning experiences to understand concepts, scientific processes, train scientific work and scientific attitudes of students. Chemistry can be seen as a product and process. Chemistry as a product includes a collection of knowledge consisting of facts, concepts, and principles of chemistry, while chemistry as a process includes the skills and attitudes possessed by scientists to acquire and develop knowledge. So, that science generic skills of symbolic language, logical consistency, and logical inference are needed in chemistry learning.

Chemistry learning requires intellectual skills such as collecting and analyzing data to solve the problems, formulate hypotheses, control variables and define operations. These processes require a high level of logic ability. Based on the importance of this, several authors have urged to make the development of logical abilities as a top priority in education (Savant, 1997). Logic inference skills are generic abilities to be able to get new conclusions as a logical result of laws, principles and rules first with or without conducting experiments (Brotosiswoyo, 2000).

Practical activities are very needed on science generic skills. It is the concept of understanding skills associated with action. Especially direct observation skills, because with good observation skills, students will be able to record all phenomena during the practical activities. In addition, chemistry also requires students to recognize the symbol of elements, compound formulas, equation of reactions, and symbols of unidirectional reactions and equilibrium reactions.

The 2013 curriculum actually accommodates 21st century skills, in terms of content standards, process standards and assessment standards. The 2013 curriculum has the essence contained in Permendikbud No.24 of 2016, covering basic competencies and four core competencies, namely (1) spiritual competence, (2) attitude competency, (3) knowledge, and (4) skills. These competencies are achieved through intracuricular, cocuricular and extracurricular learning processes. Core competencies must have a balanced quality between hard skills and soft skills achievements. Core competencies of knowledge requires students to understand, apply, and explain factual, conceptual, procedural, and metacognitive knowledge in science, technology, art, culture, humanity, national, state, and civilization insights related to the causes of phenomena and cases, and apply procedural knowledge to specific fields of study according to their talents and interests to solve problems.

Based on curriculum 2013, students are required to show their attitudes as part of the solution to various national problems in interacting effectively with the social and natural environment and in placing themselves as a reflection of the nation in the world, for that learning that can utilize culture is needed (Kemendikbud, 2013). Learning that can relate science with a

developed culture in the community is needed. The suggested scientific approach in education in Indonesia at present is Ethnoscience, which is original knowledge in the form of language, customs and culture, morals, as well as technology created by certain people or people who hang on to implicit knowledge. (Mahendrani & Sudarmin 2015).

The importance of ethnoscience learning for empowering student's knowledge that has been embedded in students to develop original knowledge in a society with integrated learning model packaging, namely the use of Science, Technology, Engineering and Mathematics (STEM) learning models that modified with ethnoscience approach (Parmin in Khoiri, 2018). STEM is a learning approach integrated with various disciplines. STEM allows students to learn academic concepts appropriately by applying the four disciplines (science, technology, engineering and mathematics).

The STEM approach has several characteristics including technology-based, the use of technology such as laptops, cellphones, tablets, *etc* are an effective and efficient way of conveying information. There are various kinds of technology that have been developed as educational facilities, including the use of computer software as a learning media, educational games (Klopfer *et. al.,* 2009; Prasetyo *et. al.*, 2014), online learning, e-book (Redhuan, 2014) and E-book (Setiawan & Wardhani, 2018).

E-book is a learning tool because it is a technology that utilizes computers as learning media (Candra, 2016). E-book can be form with a variety of files. Some are in the form of *pdf* (portable document format) that can be opened with the *Acrobat Reader* program or the other like. There is also a form of *htm*, which can be opened by browsing or internet explorer offline. There is also a form of *execute* (*exe*). In most, e-books use in the *pdf* form. Because it is easier to use it and be protected by a password (keywords) so that other users can't change the content of the e-book (Haris, 2011).

Based on the above problems researchers analyzed the effect of the implementation of the ethnoscience integrated STEM e-book on the science generic skills in chemical equilibrium topic.

METHODS

The research method in preparing this thesis is an experimental method. The research design used was the *Pretest- posttest Control Group Experiment.* In this design, Sugiyono stated "that there are two groups, each of the are randomly chosen. The first group was given treatment (X) and the other group was not. The treated group is called the experimental group and the untreated group is called the control group" (Sugiyono, 2012). In the research design there are steps that indicate a sequence of research activities, the stages in the experimental class are: 1) the initial test stage 2) the implementation stage of the ethnoscience integrated STEM e-book (X1), 3) the Final Observation (O) stage, while stages in the control class are: 1) the initial test stage, 2) the stage of the application of school materials, 3) the final Observation stage (O).

This research was conducted in Semarang 12th High School in November to December 2019. The sample in this study will be taken by cluster random sampling technique, which is taking sample members from the population that is done in a simple random (Sugiyono, 2010). Based on the survey in the place of research, the samples used were 33 students of class XI Science 3 as the control class and 33 students of class XI Science 4 as the experimental class.

Data collection techniques that used are completely groundless test multiple choice questions of 20 questions and the questionnaire sheet of students' responses to a ethnoscience integrated STEM e-book. The data analysis technique that used is the test of average difference, analysis of the effects between variables, and stipulation of the determination coefficient.

RESULTS AND DISCUSSION

The results of research in the form of data enhancement N- *gain* learning outcomes and student's science generic skills indicator, they are symbolic language, observation, logical inference and logical consistency. Measurement of learning

outcomes used multiple choice tests and measurement of science generic skills used reasonable multiple choice tests. The research data were obtained from two classes. XI Science 4 as an experimental class, it consisting of 33 students. XI Science 3 as a control class, it consisting of 33 students. The control class used teaching materials that provided by the school with the *Problem Based Learning* model and *offline* learning. In the experimental class used the *Problem Based Learning* learning model and e-book teaching materials with integrated ethnics STEM and learning is done by *online* and *offline. Online* learning used *google classroom* to upload material and assignments.

The learning activities conducted as many six meetings in the experimental class and control class. In the experimental class, the chemical equilibrium topic is taught with the help of integrated Ethno-STEM e-book teaching materials. Ethno-STEM integrated teaching materials on the topic of chemical equilibrium are linked with ethnoscience elements so that students are able to easily learn from the culture, habits or local wisdom of the local community. The element of local community's wisdom delivered in the form of limestone burning by collectors uses calcination techniques. In the combustion process an equilibrium reaction occurs between the limestone with burnt lime (*tohor* lime) and carbon dioxide. Lia, *et al.* (2016) states that learning resources oriented to culture or ethnics can help students understand the distinctive culture contained in their area.

The first meeting in the experimental class begins with carried out the *pretest* and introduction learning. The step after gave a *pretest* is to provide teaching materials for chemical equilibrium e-book for students through *Google classroom.* Students are given steps to use *google classroom* and download teaching materials that have been provided in *google classroom.*

Ethno-STEM integrated chemical equilibrium teaching materials are distributed through *google classroom* on the Classroom Assignment menu. This teaching material is packaged to be used by students independently at home. Access to ethno-STEM integrated e-book teaching materials can use computer media, laptops, *ipad* and mobile phones. These various accesses make it easier for students to repeat or review learning material, anywhere and anytime. As did Koriaty & Manggala (2016) and Hasbiyati & Khusna (2017) that e-book can increase student's interest in learning. This reinforces that student who use e-book as a source of learning will have an interest in learning so that the willingness to learn independently at home will also increase.

The use of integrated chemical equilibrium material Ethno-STEM e-book affects the cognitive learning outcomes of students. The cognitive aspects of students can be measured using a multiple choice test instrument. Improved learning outcomes on chemical equilibrium material can be seen in Figure 1.

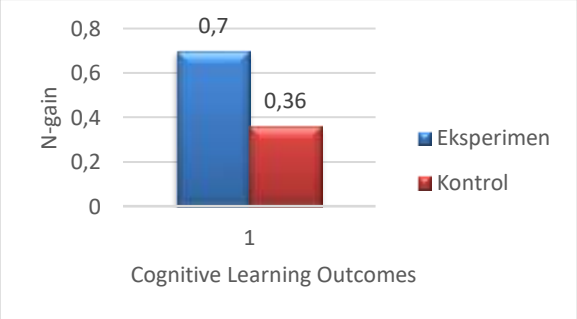

Figure 1. Improving Cognitive Learning Outcomes of Students

Figure 1 shows that cognitive learning outcomes of students have increased significantly. In the control class an increase of 0.36 in the medium category, while in the experimental class an increase of 0.70 in the high category. The experimental class experienced a higher increase than the control class.

The effect of the use of Ethno-STEM integrated chemical equilibrium teaching materials on cognitive learning outcomes can be shown by the correlation value (r). Cognitive learning outcomes of students were analyzed using *pretest* and *posttest* data between the experimental class and the control class. The results of the analysis of the achievement improvement and the effect of integrated Ethno-STEM teaching materials on student's cognitive

learning outcomes on the *pretest* and *posttest* scores are presented in Table 1.

Table 1. Achievement Results and Tests of the Effects of Integrated Ethno-STEM Teaching Materials on Cognitive Learning Outcomes

Class	Posttest grade point average	N-gain	r_b	t_{count}	Influence Weight (%)
Control	51.21	0.36 Low	0.90	1.76	82%
Experiment	78.64	0,70 High			

Table 1 shows that the percentage of student's cognitive learning outcomes in the experimental class using Ethno-STEM integrated teaching materials on the topic of chemical equilibrium is 78.64 %, while the percentage of student's cognitive learning outcomes in the control class using Ethno-STEM integrated teaching materials that is equal to 51.21 %. The interpretation of the value of r_b is classified in the strong category, so it can be said that the integrated teaching material Ethno-STEM is a factor that gives a strong effect on student's cognitive learning outcomes. The correlation coefficient is used to test the research hypothesis. H_o if the value of $t < t_{(1-\alpha)(n1+n2-2)}$. With n1 = 33, n2 = 33, and α = 0.05, we get the value of $t_{(1-\alpha)(n1+n2-2)} = 1.694$. The analysis results obtained for $t_{arithmetic} = 4.97$ and $t_{table} = 1.694$. Because $t > t_{(1-\alpha)(n1+n2-2)}$ or 4.97> 1.694 then H_o is rejected, which means that there is a relationship between the use of integrated teaching material on the topic Ethno-STEM chemical equilibrium towards cognitive learning outcomes of students. The magnitude of effect is determined by the coefficient of determination (CD), obtained CD = 82%.

Science generic skills of students can be known through the results of the *pretest* and *posttest* using multiple choice reasoned instruments with a score for true answer and 0 score for false answer. Student's science generic skills are measured based on achievement and a large increase in student's science generic skills before and after learning. Figure 2 shows the average acquisition value of science generic skills per indicator in the experimental class and the control class.

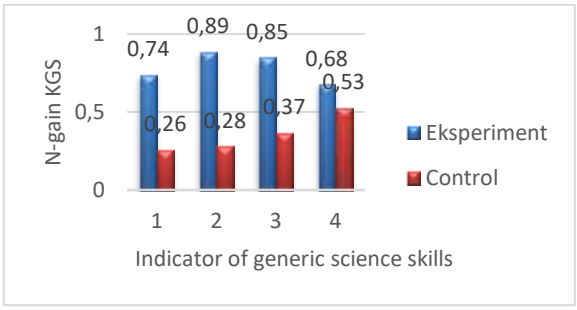

Figure 2 Improvement of each indicator of student's science generic skills
Description: Science Generic Skills 1) Logic Inference, 2) Symbolic Languages, 3) Logical Consistency, and 4) Direct Observation.

Figure 2 shows that each indicator of the science generic skills of students tested has a significant increase. In the control class an increase of 0.53 in the medium category in the direct observation indicator, while in the experimental class an increase of 0.89 in the high category in the indicator of the science generic skills of students, it is symbolic language. In the control class the lowest increase in the science generic skills indicator is logical inference of 0.26 in the low category, as well as the experimental class, the lowest increase in the science generic skills indicatoris is for direct observation of 0.68 in the moderate category.

Mahendrani (2015) states that the development of photography ethnic e-book which is applied to the effective learning process of student learning outcomes with an increase from the cognitive domain with classical completeness 86.44% and N-Gain by 0.5 with a level moderate achievement and activeness of students in the very active category.

To find out the significant differences in the results of science generic skills on each indicator studied between the experimental class and the control class a t-test was conducted. The results of the t-test analysis of student's science generic skills on each indicator are presented in Table 2.

Table 2. Science Generic Skills T-test

Indicator	1	2	3	4
Test Value T	2.07	2.32	1.79	3.45

Table 2. shows the results of the t-test analysis which means that if the value of $t_{arithmetic} > t_{table} = 1.694$, it can be said that there are significant differences between the experimental class and the control class that use different teaching materials. T-test results show the value of $t_{arithmetic} > t_{table}$ so that all indicators of student's science generic skills there are significant differences. This means that there is a significant difference between the experimental class that uses the chemical equilibrium teaching material that is integrated Ethno-STEM with the control class that uses ordinary teaching material.

The results of the questionnaire responses of students to teaching materials e-book chemical equilibrium integrated Ethno-STEM statement learners' response to good categories. Students state that the ethno-STEM integrated chemical equilibrium teaching material e-book causes: (1) makes it easier to learn the material, (2) makes it easier to learn independently, (3) the material taught is interesting, (4) the learning done motivates to study more diligently, (5) material related to local wisdom helps improve understanding, and is complemented by (1) pictures that clarify the material, (2) material presented simply and clearly, (3) material presented coherently, (4) availability and clarity of the answers to the practice exercises, (5) the suitability of the questions with the material, (6) the accuracy of the color selection, (7) the clarity of the images, (8) the images in the e-book are interesting, and (9) the type and size of letters are easy to read. This is in appropiate with research conducted by Setiawan, *et al.*, (2017) states that the use of local wisdom-based modules can increase student's scientific literacy. Astuti & Setiawan (2013) in their research also stated that student worksheet is not the only source of learning for students, so teachers are expected to give advice to students to look for or read other relevant sources. Learning using this ethnoscience-based worksheet can make students gain hands-on experience looking for information from observations using their senses, from food producers and from other sources.

Beside having advantages, integrated Ethno-STEM e-book teaching materials also have limitations, that is the quality of the material presented is still lacking, learning is not enjoyable and the questions and assignments given are less helpful in strengthening student's understanding of learning material. This is because students are not accustomed to using teaching materials that are associated with the habits of local communities.

The analysis results of the effect of the ethnoscience integrated STEM e-book implementation on student learning outcomes obtained biserial coefficient of 0.90 included in the high category with a coefficient of determination of 82%. While the effect on the science generic skills of students obtained biserial coefficient of 0.97 included in the high category with a coefficient of determination of 95%. So it can be concluded that the chemical equilibrium e-book teaching materials containing integrated ethnics STEM contribute 82% to the learning outcomes of students and 95% to the science generic skills of students.

CONCLUSION

The application of ethnics-integrated STEM chemical equilibrium e-book contributed 82% to the learning outcomes of students and 95% to the science generic skills of students with N-*gain* each increased by 0.70 and 0.77. Based on the results of the study it can be concluded that the chemical equilibrium e-book containing integrated ethnics STEM has a significant effect on cognitive learning outcomes and student's science generic skills.

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