



THE EFFECTIVENESS OF SCIENTIFIC APPROACH USING ENCYCLOPEDIA AS LEARNING MATERIALS IN IMPROVING STUDENTS' SCIENCE PROCESS SKILLS IN SCIENCE

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ABSTRACT

A scientific approach for biology students in the Vertebrate course is needed in order to improve the skills and enrich the experience for new spirit of learning. The research was a quantitative research aiming to explain the influence of the encyclopedia as learning materials used in the scientific approach to improving the students' science process skills. Meanwhile, to reveal the influence of each indicator in each predictor, a qualitative descriptive analysis was employed. The encyclopedia was found to be able to provide visualization to represent an explanation. The respondents in this study were biology students who attended the Vertebrate course. Thirty respondents were selected through a cluster random sampling technique. A test of science process skills was the instrument of this research. Furthermore, the ANOVA was utilized in testing the hypothesis. The analysis results showed that there was a different effect of the learning approach on the basic science process skills. Moreover, there was also a significant influence of the scientific approach to basic science processing skills at a significance level of 0.001 (on corrected model) with F value equal to 7.411. Meanwhile, the significance level for basic science process skills was 0.024 with the p-value <0.05 and F value of 5.357. For the integrated science, there was a significant effect of the learning approach to the integrated science process skills at the significance level of 0.000 with the F value of 12.537. The significance value for the integrated science process skills was 0.044 with p-value <0.05 and F value of 4.224.

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Keywords: encyclopedia, scientific approach, science process skills

INTRODUCTION

Improvement of the quality of education is a continuous process from school to college. One of the ways is to train students' skills, and the potentially empowered skill is the science process skills. Science process skills (SPS) define as the development of insight into intellectual, so-

cial and physical skills derived from the basic abilities found in students (Ostlund, 1992; Ozgelen, 2012). The science process skills are necessary for discovery, inquiry and thinking process which help students be lifelong learners (Farsakoglu, 2012; Cigrik & Ozkan, 2015). The sciences process skills (SPS) are divided into two; the basic and integrated SPS. The observation, measurement, classification, conclusion, prediction, and communication belonged to the basic SPS.

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Meanwhile, the integrated science process is a combination of two or more basic science processes (Kemendikbud, 2011; Nworgu & Otum, 2013). Integrated science process skills include some variables such as controlling, operational definition, hypothesis formulation, data interpretation, and experimentation (Chabalengula, & Mumba, 2010; Lancour, 2006; Padilla, 1990). The improvement of various skills can be done in many ways, by applying various learning approaches, for instance. The scientific approach was chosen in this study since it has been proven to be able to achieve a better learning outcome. A study by Dyer et al. (2011) discovered a concept known as the five discovery skills based on creative intelligence, an intelligence that is beyond the cognitive ability and involves two sides of the brain to create new ideas using 5 skills: associating, questioning, observing, experimenting, and networking (Dyer et al., 2009).

A scientific approach is also called a scientific-based approach. The process aims to acquire systematic scientific knowledge. The scientific approach roots in a scientific method, a concept that emphasizes science more as a verb rather than a noun. The scientific method is a procedure or process that gives priority to more active and participatory methods (Simonneaux, 2014; Baars, 2011; Reid, 2008). This kind of learning strategy can support students to develop hands-on and minds-on (Duda, 2010) as well as their basic ability such as communication skill, interpersonal relation, critical thinking, and problem-solving skill (Lazanyi, 2012). This is strengthened by Kumar (2013) and Prain (2012) who stated that to be able to live in a good competition in the 21st century, young generations must at least own these abilities; communication skill, interpersonal relation, critical and rational thinking, problem-solving, risk-taking, cooperating skill, innovative skill, leadership, and technology. To support the development of hands-on and mind-on students, the use of encyclopedia as teaching materials during has been considered important. An encyclopedia gives a better explanation (Yu & Lam, 2008) and it helps explaining everything as a phenomenon (Mills et al., 2010). An encyclopedia is equipped with scientific information and supported by original photographs. Komalasari (2011) argued that an image or photograph can provide a real picture to show the real object, give livelier learning atmosphere and it is more accurate than words, so as to stimulate the thinking ability of learners.

Abruscato (1995) pointed out a reason why some students were less successful in becoming active and independent students since they were less aware of their basic process skills. Kruea-In Buaraphan (2014) suggested that students' science process skills could be nurtured through proper instruction. Hodosyova et al. (2015) explored the relationship between basic science process skills and learning outcomes. They found that having sufficient understanding and science process skills are considered an important aspect in learning science. Some researches have shown how important science process skills is to be owned by students; however, it should not be forgotten that the integrated science process skills will not be proper if the basic science process skills required by students are not trained from the beginning. Therefore, the basic science process skills must be owned by students before they develop other skills. Fortunately, all these skills can be learned and obtained at school. To support science learning, students should not only learn facts, concepts, laws, and theories in science, but they should also learn the process of how products of science are created. Students should not only learn the products but the process, attitudes, and technology in order to truly understand science as a holistic (Mariana & Praginda, 2009).

There has been no published research on the influence of the encyclopedia-based scientific approach to the students' science process skills. Thus, this study aimed to determine how strong the influence of the scientific approach to science process skills. Furthermore, it was expected that the research results could provide knowledge in the effort to improve the quality of education and the mastery of skills, as well as to enrich the students' experience and grow their passion in learning Biology. The main purpose of this study was to describe the effectiveness of encyclopedia-based scientific approaches to the students' science process skills.

METHODS

This research was carried out to determine the influence of encyclopedia-based scientific approach on the students' science process skills. Meanwhile, to observe the influence of each indicator from each predictor, a qualitative descriptive analysis was used. The researchers had performed this study for 1 semester. The sample in this study were pre-service teachers in biology program amounted to 105 students divided into

five classes. The respondents were 30 students selected through the cluster random sampling technique. The design used quasi-experimental, control group, post-test only design (Creswell, 2012).

The research instruments were tests on basic and integrated science process skills consisting of 20 validated items. The given test was in the form of an essay based on indicators presented by Chabalengula & Mumba (2010), Lancour (2006), and Padilla (1990) as mentioned above. There were two questions for each skill.

Prior to the test, a trial test was done to 32 respondents who were not the research sample. This trial aimed at determining the validity and reliability of the items. The reliability test using

Cronbach's Alpha showed a result of 0.847 for the basic science process skills and 0.876 for the integrated science process skills.

The data were statistically tested using the ANOVA with a significance level of 5% ($p < 0.5$) (Kozub, 2010; Gamst, et al, 2008). The data obtained were first tested on the prerequisite normality and homogeneity test. All data analysis was performed using statistical package for the social sciences version 23.0 for windows.

RESULTS AND DISCUSSION

The results of data analysis to determine the influence of scientific approach to science process skills of biology students are presented in Table 1.

Table 1. Summary of Scientific Approach Analysis to Basic Student Science Process Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	122.510 ^a	2	61.255	7.411	.001
Intercept	1630.843	1	1630.843	197.312	.000
Group	100.876	1	100.876	12.205	.001
Pretest_kps_basic	44.281	1	44.281	5.357	.024
Error	553.776	67	8.265		
Total	24082.000	70			
Corrected Total	676.286	69			

Based on the results of covariate analysis, it explained that there was a different effect of learning approach on the basic science process skills by eliminating the pre-test of basic SPS as a covariate at the significance level of 0.001 with a value far from 0.05. Simultaneously, there was a significant influence of the scientific approach to the basic science process skills at the significance

level of 0.001 (on the corrected model) with the F value of 7,411. Meanwhile, the significance value for the basic science process skills was 0.024 with p-value < 0.05 and F value of 5.357.

The next analysis was to test the influence of the scientific approach to the integrated science process skills among biology students. The analysis results are presented in Table 2.

Table 2. The Effect of Scientific Approach on Integrated Student Science Process Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	118.350 ^a	2	59.175	12.537	.000
Intercept	1269.431	1	1269.431	268.951	.000
Group	64.309	1	64.309	13.625	.000
pretest_kps_integrated	19.935	1	19.935	4.224	.044
Error	316.236	67	4.720		
Total	9877.000	70			
Corrected Total	434.586	69			

The significance value of the corrected model shown in Table 2 signaled that there was a significant effect of learning approach on integrated science process skills with the significance level of 0.000 with the F value of 12.537. Meanwhile, the significance value for integrated science process skills was 0.044 with the p-value <0.05 and F value of 4.224. Moreover, the scientific ap-

proach had a significant effect on the integrated SPS with pre-test as the covariate at significance level of 0.05. The obtained value of significance was 0.000.

Results of analysis of student activity based on the results of observation on the learning process with the scientific approach are presented in Table 3.

Table 3. The Analysis of Student Activity

Activities	Score (%)							Means
	1	2	3	4	5	6	7	
Observing	60	60	65	65	77	88	88	71.86
Questioning	80	66	78	78	77	88	88	79.29
Experimenting	83	83	83	88	88	88	88	85.86
Associating	66	66	83	83	66	83	83	75.71
Communicating	66	67	67	83	83	83	83	76.00

A learning process using scientific approach gave relatively good results. The average score was lower than 80, which indicated that some activities such as the observing, reasoning, and communicating need detailed emphasis during the learning process. The learning habit using the scientific approach could improve the students' ability both cooperatively and collaboratively. Therefore, the exploration through learning activities in observation, making inquiries related to observations, conducting experiments, reasoning and communicating results through various interpretations needed improvement (Hernawati et al., 2018). The accumulation of all these stages would improve the intellectual ability, especially in higher-order thinking skills.

Based on the behavioral theory (Schunk, 2012), observation and learning behavior could give impacts to the learning implementation. Several things suggested in behavioral theory include the emphasis on stimulus presentation and strengthening of responses (Thorndike's learning theory), habituation (Pavlov's theory), strengthening (Skinner's theory) need to be the attention for all activities. Based on facts, the concept of meaningful learning as explained in Ausubel's theory is still needed to strengthen through various intellectual skills abilities.

There were seven reports of experimental activities undertaken by students during the learning process using the encyclopedia as the learning materials. The results of the analysis are presented in Figure 1.

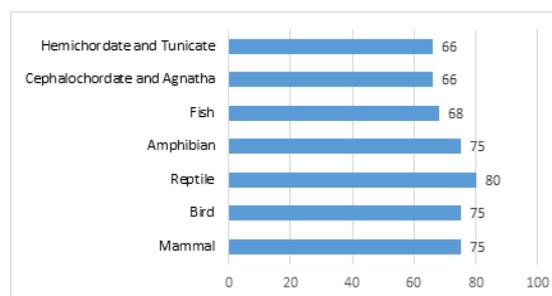


Figure 1. The Analysis of Students' Outcomes based on Experimental Activity

There were seven subjects that the students learned during the research explicitly hemichordate and tunicate, cephalochordate and agnatha, fish, amphibians, reptiles, birds, and mammals. The implementation of learning in the experimental class was carried out based on the steps of the scientific approach, which referred to the decree of Ministry of Education and Culture (Permendikbud) No. 103 Year 2014 by including several items as suggested by Dyer et al, (2009) such as observing, questioning, experimenting, associating, and communicating. In the last five years, conventional classes applied to conventional laboratory work.

The results indicated that active learning involving students in science process skill is needed during the learning process. This kind of activity allows students to improve their critical thinking ability in order to reach their academic target (Tutiaux-Guillon, 2008). Science process

skill was developed through innovative learning and collaborative group study. Chan et al. (2016) stated that any learning activity involving the variety of group discussions would improve students' interpersonal skill. Innovative learning often requires students to develop more autonomy and responsibility as well as self-awareness due to the student-centered activities (Bédard & Béchar, 2009). Some researches stated that science process skills could develop cognitive skills and support students' thinking, intellectual, examining, and problem-solving skills (Ozgelen, 2012). Thereover, there is a strong correlation between the students' science skills with the properties of science process skills. Previous studies have shown that science process skills are the important part that influences students' achievement (Baser & Durmus, 2010).

The observing skill is the most important thing for developing the other process skills (Abruscato, 1995; Carin, et al., 2005). Performing a measurement requires knowledge to use the measuring equipment properly (Abruscato, 1995; Carin, et al., 2005). Classification is a process skill for selecting various objects based on certain traits (Abruscato, 1995; Carin, et al., 2005). Furthermore, the inferencing skill refers to the development of possible conclusions. Predicting skill relates to making specific statements about everything based on certain patterns or trends. Valid prediction requires precise and correct determination (Abruscato, 1995; Carin, et al., 2005). Meanwhile, the communication skill is an effort in conveying relevant ideas. All of these basic science process skills are required as a bridge to improve the integrated SPS. This explanation is related to the study of Prihatnawati et al (2017) that science process skill could be improved with the module as the teaching materials.

The integrated SPS is essentially the skills needed to conduct research (Abruscato, 1995; Carin et al., 2005). Similar skill is required in defining operational variables that covers certain considerable limits depending on the area of science. Operational definitions are varied depending on the subject, for example, recognizing the attributes of independent variables, the scope limitation of the dependent variable (Abruscato, 1995). Data interpretation involved other science process skills, such as tabulating the data, drawing conclusions, and analyzing the data either quantitatively or qualitatively as a basis for testing the hypotheses. Experimenting defines as a skill to conduct testing on ideas originating from facts, concepts, and principles of science (Abruscato, 1995).

The process skills are the assimilation of various intellectual skills that can be applied to the learning process (Feyzioglu, 2009; Ozturk et al., 2010). Based on the Piaget's cognitive development stage, basic skills can be nurtured in the early stages of cognitive development, while the integrated skills can be introduced later in the formal operational development stage (King, 2011). Thus, the existence of the scientific approach with five aspects including observing, questioning, experimenting, associating, and communicating, supports the improvement of students' science process skills. Triyuni (2016) stated that scientific approach provides a positive and good learning environment that is conducive to improve the students' skills.

CONCLUSION

Based on the above discussion, the scientific approach applied in the learning process has proven effective in improving the basic SPS and integrated SPS among biology students. The statistical analysis informed that scientific approach significantly influenced the basic SPS and integrated SPS of biology students. In sum, the scientific approach had the right learning syntax to enhance and develop the students' academic abilities and gave them various skills.

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