HOTS Integrating STEM Learning Approach in the Nutritional Sciences Learning at The Higher Education Level

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Abstract- The empowerment of High Order Thinking Skills (HOTS) is very important in preparing graduates to participate in the globally competitive, entering the work face, and encountering the new industrial revolution 4.0 era. This study aims to (1) Determine the effectiveness of the STEM approach in empowering the HOTS of Students; (2) Determine the effect of STEM approach on the HOTS of pre-service students in the nutritional sciences learning at the higher education level. The research is quasi-experimental with nonequivalent pre-test post-test design. Analysis of covariance (ANCOVA) used to analyze pre-test and post-test data, with the pre-test data as a covariate. The results showed that the HOTS average experiment class was higher than the control class. Based on the results of a statistical test its concluded that there is a significant effect of the STEM approach in empowering HOTS in science nutrition learning at the higher education level. Consequently, the STEM approach is effective in empowering HOTS in nutrition science learning at the higher education level.

Index Terms- HOTS, STEM, Nutritional Science, Education

I. Introduction

In order to face the new industrial revolution 4.0 era, universities have to improve their quality and learning quality. The improvement can be supported through interactive, scientific, contextual, thematic, effective, and collaborative learning. Furthermore, in the industrial revolution, the graduates have to be able to encounter the globally competitive, entering the work face and encountering the new industrial revolution 4.0 era. Therefore to support those abilities, there are various learning approaches that can be used, such as the Sciences, Technology, Engineering, and Mathematics (STEM) learning approach. STEM can accommodate the various fields of science, such as science, technology, engineering, and mathematics into a unified holistic [1], [2]. STEM education plays a vital role in establishing the culture and economic growth through innovation [3]. Furthermore, these four disciplines can become a basis for the development of science and technology so that the students will have competencies to entering the globalization era that changed rapidly. STEM has many potential benefits for individuals and the nation as a whole [4]. The benefits were the students can have the science and technology literacy that can be seen from reading, writing, observing, and scientific skills. It is certainly in accordance with the era of the revolution of industry 4.0 that requires the mastery of literacy and information technology.

The definition of the STEM in science about the natural world including the laws of nature that associated with physics, chemistry, and biology [5]. Technologies include in the fields, which involves the application of knowledge, skills, and the ability of human beings to produce something that can facilitate life activities [6]. Engineering is the process of designing to make a product or work steps [6]. Mathematics is a science related to numbers, operations, relationships, and shape [7]. Furthermore, there are eight-step and characteristics in STEM education, such as (1) asking questions (for science); (2) developing and using models; (3) planning and carrying out investigations; (4) analyze and interpret data; (5) using mathematics and thinking computing; (6) constructing explanations (for science); (7) arguments the proof; (8) obtaining, evaluating, and communicating the information [8].

A variety of learning approaches conducted in learning activity so that the understanding of the theory and lecture material can be well understood by the students. To determine the success of learning activity can be seen from the various indicators, knowledge mastery, attitudes, and skills. Moreover, the thinking process in the Bloom's taxonomy entered in levels of cognitive. Where the level of cognitive includes six (6) levels, such as; knowledge, comprehension, application, analysis, evaluation, and creation. It is based on

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levels of thinking skills, starting from the lowest level to the highest. The ability to think on a HOTS in the Bloom's taxonomy includes the process of analyzing (C4), evaluating (C5), and creating (C6) [9],[10].

The empowerment of the High Thinking Order Skills (HOTS) is one of the indicators in measuring student success in concept mastery. HOTS is very important for the students to help analyze the problems. Where in solving problems, students were required to think creatively. Students who have high ability levels will be easier to solve the problem [11]. While the definition of HOTS according to is an person's ability to control their plan, evaluate and monitor progress, be flexible, adaptable, and can solve problems in various contexts [12].

High level of thinking skills was divided into four groups; problem-solving, decision making, creative thinking, and critical thinking [13]. A high level of thinking that involves various types of exploration of questions related to issues that are not clearly defined and do not have a definite answer. Therefore, the necessary exercise of drawing up explanations, exercises make a hypothesis, generalizing, and documenting those findings with evidence. Based on some opinion, then HOTS can be defined as a skill of high-level thinking that requires thinking critically, creatively, analytically, to information in solving a problem.

Nutrition science learning is one of the compulsory subjects in the curriculum of higher education in the biology education department of IKIP Budi Utomo Malang. The learning activities of nutrition science particularly have not been able to accommodate the output-oriented in the 21st century, especially the HOTS. That because of the Less synergy between the lecturer, learning methods and learning models, technology, and human resources, so that the output not at the maximum level. The observation results showed that 60% of the students still have a low level of HOTS, especially on the nutrition science subjects. This is due to the learning process that occurs in IKIP Budi Utomo that is starting to lead to a paradigm of student-centered learning, but not all of the lecturers enrich the skills of HOTS. Moreover, the STEM used to make nutrition science learning became meaningful and deep learning. Referring to the gap analysis, the problem in this research is how the effectiveness of STEM in empowering HOTS of nutrition science learning at IKIP Budi Utomo Malang?

II. Literature Review

A. STEM (Sciences, Technology, Engineering, and Mathematics)

STEM is a learning approach that integrates the four areas of science, technology, engineering, and mathematics into one unified holistic [1]. STEM as the following: (1) the science of representing the knowledge about the law and the prevailing concept of nature; (2) technology as a skill, or a system used in regulating the society, organization, knowledge or the design and use of tools created to facilitate the work; (3) Engineering as the knowledge to operate or design a procedure to solve the problem; (4) Mathematics as a science that connects to the scale, numbers and space which only requires logical arguments without or accompanied by empirical evidence [14]. Thus, the purpose of the STEM approach is that the learners have science and technology literacy that can be seen from reading, writing, observing, and scientific skills, and then able to develop that applied skills in facing daily life problems [1]. Some empirical research proved that STEM learning has the potential to generate a competitive upcoming labor force with 21st-century skills [2], [15].

B. High Thinking Order Skill (HOTS)

The high order thinking skills (HOTS) ability was the ability to understand, analyze, synthesize, evaluate and create a concept so that the concept can be understood and attached to the student's long time memory [16]. HOTS has some indicator to include: (1) analyzing (analyzing), where the learners should be able to decipher or detailing a problem in the form of a question into a section more specific and able to connect the part; (2) evaluating, learners able to make consideration of a condition, method, or idea; (3) Creating (creating), learners should be able to synthesize knowledge or information into new knowledge [17]. HOTS has another name, namely the metacognitive ability, which means the individual knows the time to take control of his plan, evaluate and monitor the progress, to be flexible, adaptable, and can cope with problems in various contexts [12]. Thus, HOTS was an ability to take control of the plan, evaluate and monitor the progress, flexible, adaptable, and can cope with problems in various contexts. HOTS can be achieved through many activities that not just memorize the material.

III. Methods

A. The Research Design

Quasi-experimental research was applied through the pre-post nonequivalent design, where the control and experiment class from the 2016 biology education department at one of the higher education levels in East Java, IKIP Budi Utomo Malang. The HOTS data obtained from the pre-test and post-test scores of the control and experimental class. The research design is contained in Table 1.

Table 1. Research Design of Quasi-experimental with Pre-Test and Post-Test Nonequivalent

Class	Pre-test	Treatment	Post-test

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Kontrol	Y1	X1	Y3
Eksperimen	Y2	X2	Y4

B. Research Sample

Using One-Stage Cluster sampling with divide the population into groups or clusters, then some clusters were selected randomly as the representative of the population, then all elements in the cluster were selected as the research sample. The population in this research was the students of the 2016 biology education department, which divided into 2 (two) classes. The number of the overall sample were 46 students divided into two classes, 25 students in the experiment class and 21 students in the control class.

C. Instrument

The instrument was an essay questions test to measure the six indicators of HOTS aspects. The essay questions test has intervals 1-4 in accordance with the criteria, respectively. The validity of the instrument using the validity of the content, meaning that the instrument HOTS has been assessed for feasibility by the expert.

D. The Data Analysis Technique

Data were analyzed using SPSS 16.0 for Windows to determine the results of a descriptive analysis of the pretest-posttest. The test of normality using the one-sample Kolmogorov-Smirnov test, while homogeneity using the test of Levene. Then to find out the effect of the STEM towards the empowerment of HOTS using a General Linear Model (GLM)–Multivariate test ANCOVA.

IV. Results and Discussion

The results of the descriptive analysis of the HOTS showed in Table 2 below.

Table 2. Descriptive Analysis

Descriptive Statistics			
Dependent Variable (Post-test)			
Group	**Mean**	**Std. Deviation**	**N**
Control	78.4800	8.45143	25
Experiment	82.7619	6.49542	21
Total	80.4348	7.84192	46

Based on Table 2, showed there was a difference in the average score between the control and experiment class. The average score of the control class was 78,48 lower than the average score of the experiment class in the number of 82,43. That showed that the average score of the experiment class higher compared to the control class.

A. The results of the Homogeneity Test of HOTS

A homogeneity test was conducted to the HOTS post-test data. The results of the homogeneity e test showed in Table 3. Based on the calculation of obtained significance. P-level that was greater than 0.05, meaning both data were not different or homogeneous.

Table 3. The Homogeneity Test Result of HOTS

Levene's Test of Equality of Error Variances[a]			
Dependent Variable (Post-test)			
F	df1	df2	Sig.
1.460	1	44	.233
Tests the null hypothesis that the error variance of the dependent variable is equal across groups			
a. Design: Intercept + pre-test + model			

B. The results of the Analysis Test ANCOVA on the Empowerment of HOTS

Analysis of covariance (ANCOVA) was conducted to determine whether there were differences in post-test in the experimental and the control class. The test results of the ANCOVA can be seen in Table 4 below.

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Table 4. The ANCOVA Test Result

Tests of Between-Subjects Effects					
Dependent Variable (Post-test)					
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	2330.950[a]	2	1165.475	114.850	.000
Intercept	126.415	1	126.415	12.457	.001
Pre-test	2121.695	1	2121.695	209.080	.000
Model	308.422	1	308.422	30.393	.000
Error	436.354	43	10.148		
Total	300376.000	46			
Corrected Total	2767.304	45			

a. R Squared = .842 (Adjusted R Squared = .835)

The analysis of covariance (ANCOVA) results showed that F count was 114,850, with a significance value of 0.000<0.05. The significance value was less than 0.05 (p <0.05), so the null hypothesis was rejected, and the research hypothesis was accepted. That means that STEM affected the empowerment of students HOTS. Moreover, to determine the differences in the average correction of each class by using a further test technique of LSD. The summary of the LSD test can be seen in Table 5 below.

Table 5. LSD test Result

Group	Mean	Notation
Experiment class	82.7619	a
Control class	78.4800	b

Table 5 showed the difference in HOTS average in each class. The lowest average value was from class control in number 78.4800, while the experiment class average was 82.7619. It showed that the corrected average value was significant, meaning the treatment showed a significant difference with the control class.

C. Discussion

Based on the descriptive analysis, there was a difference in the post-test average value between the control and experiment classes. The HOTS average in the experiment class that implementing the STEM approach higher than the control class. This was due to the implementation of the STEM that causes the learning to become more meaningful in studying concept [18],[19]. Furthermore, it also supported by the character of STEM, such as the emphasis on science, where students required to ask a question then proceed with the planning and carrying out investigations in material science of nutrition. Moreover, to answer the problem, students analyze and interpret the data systematically from the results of the investigation conducted. Through the process of science, students were able to develop knowledge, especially their HOTS. Inline, the development of student’s skills was very important. The student's capabilities could be measured through how the students understand to learn correctly, creatively and could increasing their own skills [20]. Furthermore, the students could use science to answer the problem through scientific methods, raise and answer the hypothesis through an investigation by connecting the surrounding nature or the real world. Such activities could make students became a more creative person. On the other hand, the scientific method could make students became more creative people not only in learning activities but also in their daily lives [18].

The research findings showed there was a significant effect of the STEM implementation to empower students HOTS in nutrition science subjects. Through STEM implementation, students were able to interpret, analyze information, simplify, and solve problems so that the HOTS could increase. In addition, STEM provided an opportunity for teachers to demonstrate how concepts, principles, and techniques of the science, technology, engineering, and mathematics can be used in an integrated way in the development of products, processes, and systems used in everyday life. The increasing of HOTS indicators can be seen from the good mastery concept when students able to think high-level, where not only remember and understand the concept, but can analyze as well as synthesize, evaluate, and create a concept properly. Furthermore, the concept gained can be attached to the student's long time memory [16],[21]. The previous research showed that STEM implementation could improve the students learning outcomes, creative thinking, and

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critical thinking skills [5]. Some factors that cause students to have different HOTS ability were the level of intelligence and the ways every student face difficulty [17].

Based on the test Least Significance Different (LSD) there were differences in the average correction between the experiment and control class. That is because through STEM make students can have innovation, thinking logically and independently, have technological literacy, able to connect the culture and history with education, and able to apply their knowledge in real daily life [5]. The advantage of integrating STEM in the learning activities as it can emphasize the students to became active in the learning activities using technology products. The reason because that can encourage students to learn more actively and meaningfully so that student's critical thinking skills become higher when the students being more aware of the concept at the maximum level. The integration of the STEM approach in problem-based learning could improve student's critical thinking skills in chemistry [22].

Furthermore, there were seven reasons to involve students in the STEM approach. STEM will empower student's understanding of important science and mathematics concepts [23],[24]. Thus, students become innovative critical thinkers and can make good decisions wisely. It is because students understand how to approach and solve problems using STEM skills. It also develops a sense of ethics and social conscience among students. STEM helps the students to develop good collaboration skills and become more technologically literate. Lastly, STEM promotes students to understand how their STEM coursework will enhance their future careers [25].

Moreover, 21st-century teaching and learning using the STEM approach is one of the keys to effective, meaningful learning and in-depth understanding that can link science, technology, engineering, and mathematics among students. Thus, with the help of technological advancement, the STEM education approach should include elements of problem-solving, critical thinking, creative thinking and scientific thinking that can enhance the HOTS among students [19].

V. CONCLUSION

The conclusion was STEM implementation can empower students HOTS at the higher education levels. It is showed from the differences of the average correction of the experiment and control class in the value of the corrected average difference. The average experiment class score higher compared to the control class. Based on the statistical test results, there is a significant effect of STEM in empowering the HOTS of students in the science of nutrition at the higher education levels.

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