Certificate

Ref: 11/UN34.13/TU.1/2020

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The 7 th International Conference on Research, Implementation, and Education of Mathematics and Science 2020

organized by Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta on September, 25th - 26th, 2020

as a

Presenter

with the paper entitled :

DEVELOPING THE CURRICULUM CONTENT OF LIFE-BASED LEARNING THROUGH THE IMPLEMENTATION OF STEM-BASED MOOCS TO ENHANCE GENERIC SCIENCE AND CURIOSITY SKILLS

Yogyakarta, September,25, 2020

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DEVELOPING THE CURRICULUM CONTENT OF LIFE-BASED LEARNING THROUGH THE IMPLEMENTATION OF STEM-BASED MOOCS TO ENHANCE GENERIC SCIENCE AND CURIOSITY SKILLS

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Abstract. This study aims at (1) producing the curriculum content of life-based learning through the application of STEM-based MOOCS which is valid and practical to use, and (2) determine the effectiveness of the developed model to enhance the generic science skills and the curiosity among prospective science teachers. The research design used is a 4-D development model (define, design, develop, and disseminate). The product trial design used the pretest-posttest control group design. The trial subjects were selected using cluster random sampling technique of which two groups of trial subjects were obtained in the Biophysics class of Science Education Study Program from Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta (UNY) in the academic year of 2019/2020. The number of students was 32 people for the experimental class and the control class, respectively. The validity and practicality of the developed curriculum content were analyzed with descriptive quantitative based on the assessment from the experts and the practitioners, while its effectiveness to enhance generic science skills and curiosity was analyzed using the MANOVA test. The results showed that (1) the developed curriculum content of the life-based learning curriculum was valid and practical for science learning with "very good" category and (2) the content of the life based learning curriculum was effective in improving generic science skills and the curiosity among prospective science teachers.

1. Introduction

The curriculum of life-based learning means that learning on campus must be oriented to the development of community life to enable students to adapt to community development. One of the factors that influence learning success, especially in adjusting life development is the student's ability to transform natural phenomena or life experiences. The development of information technology with a rapid flow of information can positively impact on people who can transform it into meaningful concepts. Therefore, a transformative approach in learning is needed to build students' ability in managing all learning resources for their development. This crucial capability in facing future learning has challenged prospective science teachers to master generic science skills and enhance self-curiosity.

Generic skills have been widely discussed among education experts and working world [1]. As mentioned by Freudenberg et al. [2] that prospective science teacher students with generic skills will have better graduate employment prospects. Generic science skills are also needed among prospective science teachers to survive and improve their quality at a higher level and perform good working performance [3]. Generic science skills refer to a combination of scientific knowledge and skills [4].

Generic science is listed as one of the prominent skills that must be possessed to face the 21st century [5]. It has been urged by Haviz et al. [6] on the need to review and reaffirm the inclusion of generic science skills in science learning because these skills are part of 21st-century skills. The research results from Suhanah et al. [7] in Sumedang, West Java shows that the students' generic science skills in senior high schools are still low (38%). Similarly, Amalia et al. [8] in the initial data collection test among the students' generic science skills in the science learning class of a junior high school in Banjarmasin find it still inadequate. The same condition also happens in tertiary institutions as revealed from the observations results of the research team in the Science Education Study Program of Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta (UNY). Knowing the importance of generic science skills for students, it is necessary to find effective ways to enhance generic science skills. Through the process of science learning, these generic skills can be trained on students to make them ready to face future challenges.

In addition to generic science skills, intrinsic motivation is also crucial to support students to become independent learners. Here, curiosity plays an important role since it contains the desire for new information arising from stimuli [9]. Curiosity is a form of intrinsic motivation that is key in encouraging active learning and spontaneous exploration [10]. Curiosity is one of the important things that must be gained by prospective science teachers to improve learning outcomes [11]. Curiosity can act as a driving force for learning, new insights, and innovation for individuals and society [12]. It can be optimized through science learning as a way of thinking including belief, curiosity, imagination, reasoning, cause-and-effect relationships, self-examination and skepticism, objectivity, and open-heartedness [13].

Teachers or lecturers should be able to stimulate curiosity for their students, especially students of prospective science teachers, to give them a driving force in learning. According to Inan et al. [14], curiosity is a complex and powerful aspect of the human experience that gives rise to many collective intellectual endeavors and serves as the basic motivation. Meanwhile, Cain [15a] highlight that curiosity is a trait that encourages people to express exploratory questions and find creative ways to solve problems. Based on the interview results with several lecturers in the Science Education Study Program of UNY, it was revealed that most student still had low curiosity which was indicated by their lack of interest in the material being taught, low learning independence, and rarely asking contextual questions during the learning process. They added that only a small proportion of students have curiosity levels in the good category. The character of curiosity is in the low category with a detailed aspect of the desire to learn something new at 51.6%, the aspect of a strong attitude to know something is 49.0% and the aspect of being interested in something new is 49.8% [15b].

To develop an integrated generic science and curiosity skills, it is required a collaborative learning system with various relevant learning sources. The currently developed model that has been considered suitable is e-learning as a resource or often referred to as the Massive Open Online Course (MOOCs). MOOCs is an online interactive learning platform that can involve many participants. It is an open learning system that allows unlimited participation and is accessible via the web. This learning system provides materials, such as handouts/ modules, videos, quizzes, and interactive user forums to build a learning community. Several studies have proven that the use of MOOCs based on the students' characteristics has a huge impact on students' learning success. Learning success is not only viewed from the cognitive aspects, but also students' abilities like effective communication, collaboration skills, and self-regulation.

In this study, the Science Technology Engineering and Mathematics (STEM) model can be used as a syntax for learning development in a systematic and planned manner since the media will be ineffective without the right learning model. STEM can be brought in the classroom through virtual and social activities with the use of MOOCs [16]. Virtual learning that is associated with STEM elements will make it easier for students to carry out initial simulations to minimize the weakness of real experiments in the laboratory.

As an approach to science learning [17], STEM consist of several components, namely, science, technology, engineering, and mathematics [18]. STEM integration encourages learning based on discipline, direct, standardized, content-driven, and collaborative model ([19]). This is relevant to the findings from Rosana et al. [20] who state that the application of SETS (Science, Technology, Environment, and Society) approach through the Biophysics course has been proven as an effective solution to develop new literacy among students of Natural Sciences Study Program, Faculty of Mathematics and Natural Sciences, UNY. The application of this approach can solve the students' learning difficulties in connecting SETS elements and learning by providing integrated technology that is in line with basic competencies and learning indicators.

Based on the previous description above, it shows the urgency to develop the curriculum content of life-based learning with the MOOCs software for prospective science teachers. Therefore, this study aims at producing a life-based learning curriculum content through the application of STEM-based MOOCS which is valid and practical to use as well as effective to enhance science generic skills and curiosity among prospective science teachers.

2. Research Method

This study employed a 4-D development model (define, design, develop, and disseminate). The product trial design used the pretest-posttest control group design. The trial subjects were selected using cluster random sampling technique of which two groups of trial subjects were the Biophysics class of Science Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta (UNY) in the academic year of 2019/2020. The number of students was 32 people for the experimental class and the control class, respectively. The data were collected using tests, interviews, needs analysis questionnaires, life-based learning curriculum review sheets, product practicality sheets, life-based learning curriculum readability questionnaires, student curiosity questionnaires, and students' curiosity observation sheets, which those had been validated. The validity and practicality of the developed curriculum content were analyzed with descriptive quantitative based on the assessment from the experts and the practitioners, while its effectiveness to enhance generic science skills and curiosity was analyzed using the MANOVA test.

Table 1. The Guidelines of Generic Science Skills (GSS) Measurement Instrument

GSS Aspect	GSS Indicators	Item Quantity	Item Number
Indirect Observation	Collecting facts of the experiment results or natural phenomenon	3	1, 5, 21
Cause and effect law	Stating the relationship between two or more variables in a certain natural phenomenon	4	2, 7, 29, 34
	Estimating the cause of the Natural symptoms	5	3, 15, 25, 30, 35
Symbolic language	Understanding symbols, symbols, and terms	4	9, 11, 26, 33
	Understanding graphs/ diagrams, tables, and mathematical signs	3	4, 22, 28

Mathematical Modeling	Revealing phenomena/ problems in the form of pictures/ graphics	2	17, 20
	Proposing alternative solutions	7	6, 8, 10, 18, 19, 23, 24
	Adding a new concept	3	12, 13, 14
Concept building	Describing/ analogizing abstract concepts into daily real-life forms	4	16, 27, 31, 32
	Total	**35**	

Table 2. The Guidelines of the Curiosity Instrument

Indicators	**Item Number**	
	Statement	
	Positive	Negative
Desire to explore information (materials)	1, 9	13, 5
Interest in the material being taught	4, 12	10, 2
Raising questions to teachers and/or peers about the material	6, 14	16, 8
Motivation to find answers	7, 15	3, 11

The trial was using the pretest-posttest control group design as presented in Table 4. The experimental and control class groups were selected through cluster random sampling. The teaching material in the control class was the science textbook because the material was commonly used in schools when studying heat transfer, and the interactive teaching materials (programs) on this material were not yet available. Meanwhile, the experimental class used the developed life-based learning content.

Table 4. Pretest-posttest control group design

Group	***Pretest***	***Treatment***	***Posttest***
Experimental class	O_1	X_1	O_2
Control class	O_3	X_2	O_4

(Chawla & Sondhi, 2015)

Explanation:
X1 = Science learning using a life-based learning curriculum
X2 = Science learning using student textbooks from the Ministry of Education and Culture
O1 = Pretest of generic science skills and experimental class curiosity
O2 = Posttest generic science skills and experimental class curiosity
O3 = Pretest of generic science skills and curiosity control class
O4 = Posttest generic science skills and curiosity control class

3. Result and Discussion

3.1. Feasibility for STEM Model of Life Based Learning Curriculum Content

The feasibility assessment of the life-based learning curriculum involved two lecturers, namely the material and the media experts. The practicality assessment by science teachers was also carried out by three science teachers. The assessment result by the material experts is shown in Table 5 and the assessment from the media experts is in Table 6. The assessment results show that the STEM model of life-based learning curriculum content can be categorized as very good according to the material and the media experts.

Table 5. The Assessment Results from the Material Experts

No	Aspects	Scores	Score Conversion	Category
1	Content feasibility	3,32	A	Very Good
2	Presentation	3,69	A	Very Good
3	Characteristics of the STEM Model of Life Based Learning curriculum content	3,99	A	Very Good
4	Language	3,66	A	Very Good
	Mean	**3,66**	**A**	**Very Good**

Table 6. The Assessment Results from the Media Experts

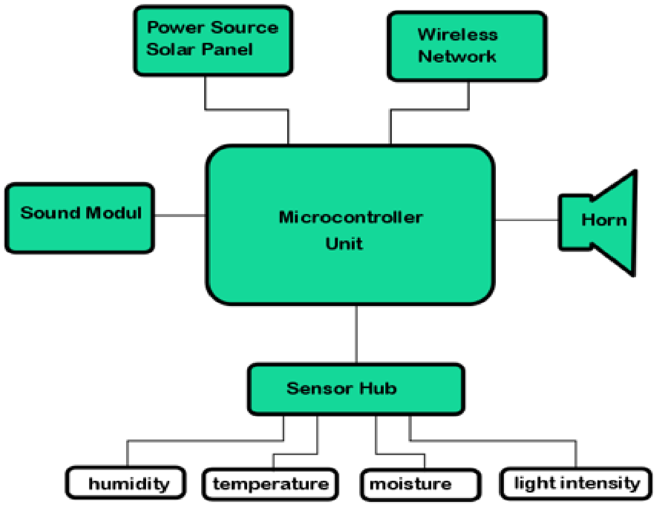
No	Aspects	Scores	Score Conversion	Category
1	Graphics	3,98	A	Very Good
2	Technical quality and use	3,78	A	Very Good
3	Characteristics of the STEM Model of Life Based Learning curriculum content	3,98	A	Very Good
	Mean	**3,91**	**A**	**Very Good**

The practicality assessment of the developed STEM model of life-based learning curriculum content by the peer lecturers involved 3 lecturers of Science Education Study Program in the Faculty of Mathematics and Natural Sciences UNY. The results of the practicality assessment were categorized very good as presented in Table 7 below.

Table 7. The practicality assessment by the peer lecturers

No	Aspect	Scores			Mean Scores	Score Conversion	Category
		Lecturer 1	Lecturer 2	Lecturer 3			
1	Presentation	3,86	3,98	3,65	**3,83**	A	Very Good
2	Technical quality and use	3,98	3,98	3,78	**3,91**	A	Very Good
3	Language	3,98	3,98	3,65	**3,87**	A	Very Good
	Mean	**3,94**	**3,98**	**3,69**	**3,87**	**A**	**Very Good**

Qualitatively, the product assessment of the developed STEM model of life-based learning curriculum, for example, is the development of agricultural technology in the form of Integrated Audio Stimulator - Multi Sensor - Pest Control (IASMUSPEC) [20]. This product has been applied in Biophysics learning and can improve student learning outcomes. An overview of the stimulator device used is as shown in the image below!



Gambar 1. . Diagram Block of Intergrated Audio Stimulator-Multi Sensor-Pest Control (IASMUSPEC)

3.2. Measuring the Application Effect of the Life Based Learning Curriculum Contents of STEM Model to enhance Generic Science Skills and Curiosity

The results of data testing indicate that nine assumptions in this study had been fulfilled before the one way MANOVA test was done [21]. The nine assumptions were that (1) two or more dependent variables were measured at the interval or ratio level; (2) independent variables consisted of two or more categories; (3) independent groups had observational independence of which there was no relationship between observations in each group or between the groups; (4) adequate sample size was required; (5) there were no univariate or multivariate outliers; (6) there was multivariate normality; (7) there was a linear relationship between each pair of dependent variables for each group of independent variables; (8) there was a variance-covariance matrix homogeneity; and (9) there was no multicollinearity.

One-Way MANOVA test on posttest data was done to determine differences in generic science skills and curiosity among prospective science teachers in the experimental and control class after the treatment. The results of the multivariate tests on the posttest data are shown in Table 8.

Table 8. Multivariate Tests Results

Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**
Intercept	Pillai's Trace	.872	1647.074^{b}	2.000	61.000	.001

	Wilks' Lambda	.017	1647.074[b]	2.000	61.000	.000
	Hotelling's Trace	44.363	1647.074[b]	2.000	61.000	.003
	Roy's Largest Root	44.363	1647.074[b]	2.000	61.000	.000
Class	Pillai's Trace	.323	14.441[b]	2.000	61.000	.003
	Wilks' Lambda	.677	14.441[b]	2.000	61.000	.002
	Hotelling's Trace	.477	14.441[b]	2.000	61.000	.000
	Roy's Largest Root	.477	14.441[b]	2.000	61.000	.002

Based on the results of the multivariate tests above, the previous hypotheses can be answered. It was obtained sig.value at most 0.003 in the Hotelling's Trace test where the value was lower than 0.005, so H0 was rejected or in other words, Ha was accepted. It means "there is a difference in generic science skills and curiosity of prospective science teachers between the experimental and the control class". These results indicate that after being given treatment simultaneously in each class, the experimental and the control class, the prospective science teachers experience differences in their generic science skills and curiosity. The next output was the test of between-subjects effects to test the effect of univariate ANOVA for each factor on the dependent variable which is presented in Table 9.

Table 9. *Test of Between-Subjects Effects*

Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	*Curiosity*	363.812[a]	1	363.812	7.633	.007
	GSS	3312.828[b]	1	3312.828	27.676	.000
Intercept	*Curiosity*	178680.866	1	178680.866	2881.623	.003
	GSS	178203.386	1	178203.386	1113.620	.004
Group	*Curiosity*	363.812	1	363.812	7.633	.007
	GSS	3312.828	1	3312.828	27.676	.000
Error	*Curiosity*	3733.633	62	60.236		
	GSS	8821.300	62	160.023		
Total	*Curiosity*	183778.223	63			
	GSS	182638.626	63			
Corrected Total	*Curiosity*	3188.367	63			
	GSS	13333.228	63			

The analysis results show that the dependent variable curiosity had sig.values at most 0.007 which was less than 0.05. It means that there is a significant difference in the curiosity of prospective science teachers between the experimental and the control class after the treatment. The dependent variable of generic science skills got the sig.value at most 0.004 which was less than 0.05, so there is a significant difference in generic science skills between the control and the experimental class after the treatment.

From the research data above, it can be seen that the increase in the curiosity score is greater than the generic science skills in both the control class and the experimental class. This is due to the emergence of the curiosity attitude that can be faster in accordance with the interest of students towards media that is relatively new to them. Meanwhile, the generic aspect of science skills develops slowly as the learning approach of Life Based Learning Curriculum Contents of STEM-Based MOOCs is used consistently.

3.3. The Effectiveness of the Life Based Learning Curriculum Contents of STEM-Based MOOCs to enhance Generic Science Skills and Curiosity

The effectiveness of the developed product in the form of the life-based learning curriculum content through the application of STEM-based MOOCS is seen from the escalation of generic science skills and the curiosity among prospective science teachers in the experimental class and the control class which was taught using the 2013 curriculum with electronic textbooks. The increase can be seen from the obtained gain scores where the experimental class got 0.43 which was in the "moderate" category, while the control class was 0.17 which was in the "low" category, respectively, for the generic science skills. In the curiosity aspect among prospective students, the experimental class had the gain score of 0.73 which was in the "high" category, and 0.21 for the control class as the "low" category, respectively. Based on the gain scores results, it indicates that science learning with the developed life based learning in the experimental class can improve students' generic science skills and curiosity.

The results of this study are in line with the research conducted by Doyan et al. [22], where the use of interactive multimedia physics can improve students' generic skills of the science teacher candidate. Mulyani et al. [23] also stated that the use of information technology-based media, such as MOOCs succeeded in having the same effect as laboratory-based learning to improve the generic science skills of prospective science teachers. The product development of curriculum content through the application of STEM clearly encourages students to learn directly about technology that is useful for application in people's lives. The use of IASMUSPEC, for example, can encourage curiosity in the short term and generic science skills in the medium and long term.

The use of life-based learning curriculum content through the application of STEM-based MOOCs in science learning has been proven to enhance the students' curiosity. The existence of multimedia elements and STEM makes this learning more attractive for prospective science teachers. Moreover, MOOCs that are full of multimedia (animation, music, sound, highlights) can attract and motivate to gather students' attention and persistence in learning the materials [24]. The increase in curiosity when using MOOCs is in line with the study from Haryanti et al. [25] where the use of MOOCs in optical material can increase the curiosity of science teacher candidates. Similarly, Kosterelioglu [26] also stated that presenting a video at the beginning of the lesson can stimulate the curiosity of student science teacher candidates. This aspect is so crucial that curiosity is part of intrinsic motivation. This is driven by the perceived benefits because the technology taught in the curriculum content can be applied directly in people's lives and at the same time fosters generic science skills.

4. Conclusion

The results of this study showed that (1) the developed curriculum content of the life-based learning curriculum based on STEM was valid and practical for science learning with "very good" category and (2) the developed model was effective in improving generic science skills and the curiosity among prospective science teachers.

Acknowledgments

The authors would like to thank the research institutes and community service of UNY for the funding support on this research project through the DIPA UNY 2020.

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7th ICRIEMS

International Conference on Research, Implementation and Education of Mathematics and Science

Universitas Negeri Yogyakarta — Jumat – Sabtu, 25-26 September 2020

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No : 199

Nama	:	**Dadan Rosana**
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