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Implementing the model of project-based learning : integrated with ETHNO-STEM to develop students' entrepreneurial characters

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Abstract. This study aimed at designing and implementing the model of project-based learning integrated with Ethno-STEM. The learning model is an approach to Science in Technology, Engineering, and Mathematics in the context of Ethnoscience. The learning model was applied to the learning of organic chemistry for secondary metabolite topics to develop students' entrepreneurial character. The subjects of this study were chemistry students who attended the organic chemistry and entrepreneurship course. The study took place in the Chemistry Department of UNNES. The research instruments included tests, observation sheets, and non-tests to measure the entrepreneurial characters. The data were analyzed using the qualitative descriptions and practicality tests of the model of project-based learning integrated with Ethno-STEM. In this study, the increase in the students' entrepreneurial characters was measured based on the N-gain score. The results of this study and discussion found (1) the character description of the model of project-based learning integrated with Ethno-STEM to develop the students' entrepreneurial characters, (2) the model was able to improve the students' entrepreneurial characters based on the N-gain scores, (3) the students were able to produce creative products and design chemical batik motifs with secondary metabolite structures on canvas and chemical bottles. The students responded positively to the developed model of project-based learning integrated with Ethno-STEM.

1. Introduction

The vision and mission of Universitas Negeri Semarang (UNNES) is to become an international conservation and reputable university, as well as an independent and entrepreneurial university in 2034 [1, 2]. The UNNES Vision and Strategy Plan surely need hard work by the academic community of UNNES. One of the facts underlying this matter is the huge number of UNNES graduates who are unable to get a job in line with their academic background. This fact is mostly found by assessors when visiting a study program. They found a low percentage of the graduates who have occupations linear to their competencies. By the time being, there are fewer chances to become government and private employees. Many graduates are expected to be either educators or scientists. However, the civil servant opportunities are limited. Therefore, one of the solutions is equipping the students with entrepreneurial characters [3] especially the students of Mathematics and Natural Sciences Faculty (FMIPA), UNNES. Nevertheless, not all of the lecturers are capable of equipping the students with

entrepreneurial characters, which means that the lecturers remain to orient to concept mastery and general skills of their educational field.

In this globalization era, entrepreneurial characters are strongly essential for the young generation. Hence, this research intended to design and apply a model of project-based learning integrated with Ethno-STEM to develop the students' entrepreneurial characters. This research was a grant research on knowledge development that was to determine an innovative learning model for providing the students with the entrepreneurial characters. The research results are expected to become a part of the educational system at UNNES. The model of project-based learning integrated with Ethno-STEM defines as an approach of a certain course in which a lecturer integrates the Science, Technology, Engineering, and Mathematics (STEM) with Ethnoscience [4]. The Ethno-STEM approach has not been widely developed, while the STEM approach has grown in many countries including Indonesia [5,6,7,8]. This model of project-based learning integrated with Ethno-STEM is also hoped for being a trend in the education world of Indonesia.

This research is very essential since the analysis results on the indicators and the research policies related to the entrepreneurial characters have been a favorable issue for the next upcoming years and an acceleration priority to realize the entrepreneurial characters at UNNES. Referring to the strategic plan of UNNES, therefore, this research becomes a sub-topic of Conservation Education and Waste Management, that is to produce creative and economic products. This study involved chemical bottle waste to be redone by painting on it certain structures of secondary metabolites. Further, the learning model was applied in the Organic Chemistry Course on traditional biotechnology of essential oil topic with the Ethno-STEM approach. The developed learning model let the students design their own project for (a) reconstructing the owner and workers' indigenous science on essential oil distillation became scientific knowledge; (b) planning a batik project as creative project from chemical bottle waste and canvas by painting certain structures of secondary metabolites on it using both natural and chemical dyes; (c) developing their critical thinking to assess and respond to the batik project. In terms of ethnoscience, the traditional essential oil distillation process done by the community comprises scientific concepts, which could be made use of as learning sources. [9].

In implementing such a learning model, the lecturer should employ a project-based learning to create economical products, observation in Ethnoscience field, lecturing, discussion, question-answer, and develop higher order thinking skills in Ethno-STEM context. In designing the model of project-based learning integrated with Ethno-STEM, the lecture must do a curriculum analysis and a study on the studied science materials, in this case, the analysis of factual, conceptual, procedural, and its relation to the Ethno-STEM. The research objective was to determine the influence of the model of project-based learning integrated with Ethno-STEM to develop the students' entrepreneurial characters.

2. Methods

This research intended to design a project-based learning model integrated with STEM and Ethnoscience or so-called the Ethno-STEM, followed by an effectiveness test to evolve the students' entrepreneurial characters. This research took place at the FMIPA UNNES, and the data were collected in the context of ethnoscience, i.e. the essential oil traditional distillation at Cepogo, Boyolali, Indonesia. The research subjects were the students attending the Organic Chemistry and Entrepreneurship course. The instruments were observation sheets, questionnaires, and test. The observation sheets were to examine the research suitability with the learning model design; also, to assess various chemical batik products on chemical bottles and canvases. The effectiveness data of the developed learning model were obtained during the implementation of the model of project-based learning integrated with Ethno-STEM and the making of batik products. The research data were analyzed through descriptive qualitative technique so as to answer the formulated problems. Meanwhile, the N-gain formula was employed to measure the entrepreneurial character aspect which is as follows:

$$N - gain = \frac{S_{posttest} - S_{pretest}}{S_{max} - S_{pretest}}$$

(1)

The classifications of the N-gain score were: (1) If the N-gain score was ≥0,7, it categorized as high; (2) if the N-gain score was $0,7 > g \geq 0,3$, it categorized as intermediate; and (3) if the N-gain was < 0,3, it categorized as low.

3. Discussion

3.1. The results of the project-based learning integrated with Ethno-STEM

Before designing the model of project-based learning integrated with Ethno-STEM, some analyses were performed on the articles related to STEM, Project-based learning (PjBL), organic chemistry, and remarkable materials of essential oil. After obtaining a valid learning model, the next step was the implementation of the model of project-based learning integrated with Ethno-STEM to develop the students' entrepreneurial characters. The learning was designed in two forms; lecturing and project assignments.

The learning comprised of six meetings. The first two meetings focused on understanding the notion of the STEM, Ethnoscience, and entrepreneurial characters. Other 2 meetings discussed the secondary metabolite compounds, isolation, identification, compound engineering techniques and the process of making essential oil, secondary metabolites biosynthesis, as well as various examples of secondary metabolites in essential oil [10,11]. The last two meetings talked about the understanding of various interesting chemical formulas of secondary metabolite compounds to be used as batik motifs, and the giving out assignments of designing motifs on chemical bottle waste and canvas. Based on the discussion results with the research team and profound analysis on plentiful sources, the characteristics model of project-based learning integrated with Ethno-STEM were determined as follows:

1. The developed learning model refers to the project-based learning proposed by Patton [12] and Ministry of Education and Culture, that is a learning intended for students to design, plan, and create products which in this case was batik of chemical structures.
2. Students made collaborative and responsible decisions in managing information to choose the target batik motif, in this case, the chemical structures of secondary metabolite compounds.
3. The lecturer continuously evaluated the batik making process.
4. The lecturer and students periodically had a reflection on the performed activities of the batik project.
5. The lecturer scored the final product either qualitatively and quantitatively.
6. The model of project-based learning integrated with Ethno-STEM was highly tolerant to the changes in raising up the students' creativity and innovation.

Table 1 presents the syntaxes of project-based learning model integrated with Ethno-STEM.

Table1. The Syntaxes of Project-Based Learning Model Integrated with Ethno-STEM on Essential Oil Topic

Phase	The Syntaxes of Project-Based Learning	The learning activities of project-based learning integrated withEthno-STEM
1	Problem orientation	The lecturer explained the learning objective and achievement, motivated the students to actively involve in the learning process, introduced science concepts related to the defition, isolation, and identification of essential oil's components.
		The lecturer introduced the essential oil refinement technologyfollowed by question-answer session,

		introduced the profit and loss calculation of rendement and essential oil business.
2	Determining essential questions	The lecturer stimulated the students by providing videos or pictures related to the essential oil refinement technology and/or presented real open-ended problems related to essential oil and Ethno-STEM.
3	Organizing the students to learn	The lecturer facilitated the students to look for information about traditional essential oil refinement technology which will be connected to the Ethno-STEM.
4.	Scheduling	The lecturer supervised the students in arranging schedule to finish the product at the target time.
5	Designing the project plan	The lecturer supported the students to collaboratively and logically design the project of chemical batik painted on the chemical bottles and canvases.
6	Supervising the project implementation	The lecturer supervised the students in implementing the designed project.
7		The lecturer and students monitored the project improvement whether it has been suitably performed according to the plan andfound out the obstacles. The lecturer would provide assistance if necessary only.
	(a) Monitoring the projectimprovement	

At the end of the learning, a test of concept mastery was carried out. The results showed that the students obtained high scores and categorized as good 4 student and very good 19 student. They were able to reconstruct the scientific knowledge related to the essential oil in terms of Ethno-STEM, for instance, the understanding of distillation, refinement, evaporation, condensation, and oil separation. Figure 1 presents the research location and the activities of essential oil distillation in Cepogo, Boyolali, Indonesia.

Figure 1. Product and Distillation Process of Essential Oil based on
Local Wisdom

3.2. The Assessment of Batik Project and the Students' Entrepreneurial Characters
The research subjects were 23 students attending the Organic Chemistry and Entrepreneurship course.
On the Entrepreneurship course, the approach employed was the Chemo-Entrepreneurship and project
design for the chemical batik painted on chemical bottle waste and canvas. Prior to that, the students
were taught the steps of batik making by the instructors (art students of UNNES); also, aided by
videos showing the techniques of bottle and canvas painting. The lecturer proposed several motifs of
'chemical batik' to give real experience to the students. Then, they were split into groups to work on
the batik project. This was a form of developing creativity and entrepreneurial sense. The products
were then evaluated by the research team and other student groups. Table 2 provides the students'
creative chemical batik results painted on chemical bottle and canvas.

Table 2. The Description of Batik in Terms of Ethno-STEM

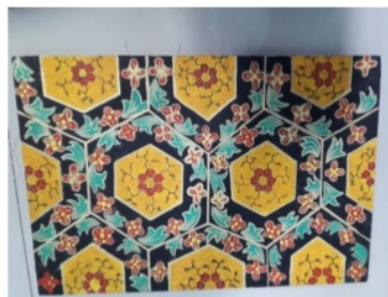| No	Chemical batik motifs	The description of batik meaning based on the STEM and expert perspective
01.		Batik type: Batik Lurik Batik motif: Contrasting colored The batik motif depicts the chemical structures of the eugynol compound from clove oil, curcuminoid, and clove flower. This was painting batik colored using artificial color and natural color obtained from curcumin extract. The batik fabric costs Rp 300.000/meter
02.		Batik type: Contrasting colored Batik Lurik (yellow, red, and white chemical structure) Batik motif: The batik motif depicts chemical structures of polyphenol compounds, curcuminoid, clove leaves, and flower. The combination of curcumin extract with artificial batik coloring resulted in the eye-catching fabric which costs up to Rp 350.00/meter.

03		Batik type: Contrasting colored Batik Lurik (brown, yellow, blue, and white) Batik motif: The batik motif portrays the chemical structure of curcuminoid. Also, a big clove flower is the center of this product. It made use of the combination of artificial color and curcuminoid extract. The batik fabric costs Rp 350.000/meter
04		Batik type: Contrasting colored Batik Lurik Batik motif: Clove flowers dominate the fabric. It surrounds the structure of aromatic, phenylpropanoid, and eugenol compounds. A natural coloring of teak leaves in combination with artificial coloring was used. The batik fabric costs Rp 350.000/meter
05		The prototype of decorative bottles is suitable for vases. The motifs depicting alkaloid and polyaromatic obtained from lignin and flavonoid. The price ranges from Rp 75.000 –Rp 100.000/piece.

On this Entrepreneurship lecture, the students were informed about the entrepreneurial characters of essential oil business owner and workers in Boyolali based on the interview results. The owner's and workers' entrepreneurial characters were: (1) persistent and perseverance, shown by their continued effort in producing essential oil despite the limited facilities, funding, basic materials, and unstable price which sometimes result in loss; (2) discipline, indicated by their target of producing the essential oil twice a month, also, their discipline in adding water or fuel, and segregating the essential oil; (3) creativity, marked by their creativity to increase rendement and make use of the waste as compost or fuels to be sold to farmers living nearby. Those three main characters were delivered to the students for them to imitate. The assessment results of the project are informed in Table 2, while the score results are presented in Table 3.

Table 3. The Scoring Results of the Students' Entrepreneurial Characters in Designing Chemical Batik

Group	The average score of Indicators									
	Motif		Attractiveness		Creativity		Color		Originality	
	Pre test	Pos tes	Pre test	Pos test	Pre test	Pos test	Pre test	Post es	Pre test	Pos test
1	80	87	81	86	81	88	80	88	80	88
2	79	87	78	85	78	87	82	88	79	88
3	78	86	80	86	80	86	81	86	79	87
4	80	87	79	86	79	87	80	86	80	87
Averag	79.3	87.8	79.5	86.8	79.5	87	81.3	87	79.5	87.5
N-gain average	0.68 [High]		0,56 [intermediate]		0.58 [intermediate]		0.44 [intermediate]		0,64 [High]	

Based on Table 3, the N-gain score average for the indicator of motif and originality categorized as high while the other indicators such as attractiveness, creativity, and color selection were in the intermediate category. There were actually six motifs produced in this research. However, only the best four of them were chosen to be displayed. Meanwhile, the batik motifs on the bottle categorized as good, had interesting color contrast and varied in chemical structures. One of the entrepreneurial characters assessed was creativity in designing chemical batik motifs which resulted in the pre-test score obtained during the designing process and the post-test score collected after the project was done. These stages were in line with Nancy's work procedures (3). The creativity of chemical batik was assessed by the groups, lecturer, expert, and posted on social media. The netizens'evaluation of the batik products was positive, indicated by 24 likes and 8 positive comments obtained within 24 hours. The products were accepted to be one of the HAKI's patents as students' entrepreneurial project. Thus, the project-based learning model integrated with Ethno-STEM was able to positively contribute to the students' creativity and entrepreneurial sense.

4. Conclusion

The results of the analysis of research data and discussion, are conclusion as follows (1) the character description of the model of project-based learning integrated with Ethno-STEM to develop the students' entrepreneurial characters, (2) the model was able to improve the students' entrepreneurial characters based on the N-gain scores, (3) the students were able to produce creative products and design chemical batik motifs with secondary metabolite structures on canvas and chemical bottles. The students responded positively to the developed model of project-based learning integrated with Ethno-STEM.

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