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The learning models of essential oil with science technology engineering mathematic (STEM) approach integrated ethnoscience

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The learning models of essential oil with science technology engineering mathematic (STEM) approach integrated ethnoscience

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Abstract. The topic of essential oil is one of the topics of the Natural Organic Chemistry course which discusses the meaning of essential oils and examples, isolation techniques and identification of essential oils, structural tests and the number of essential oil components. The next discussion was related to the engineering of the main compounds in essential oils, as well as the calculation of the yield of essential oil products. Learning of essential oils is still conventional, and less contextual, therefore in this study an essential oil learning with integrated science technology engineering mathematics (STEM) approach of ethnoscience and an integrated STEM approach of Ethonoscience has never been done by lecturers. This type of research is a qualitative descriptive study, the research subjects are the owners and workers in essential oil refining, with a focus on the reconstruction of Indegenous science based science knowledge and the design of the essential oil learning model with an integrated STEM approach to ethnoscience. Local essential oils used as research objects are clove oil, citronella oil, and traditionally produced patchouli oil. Data collection through interviews and observations at the traditional distillation of essential oils in Boyolali, Central Java. Data and information from interviews were carried out scientifically into scientific knowledge through a process of verification, reduction, validation, conceptualization, and documented as a source of essential oils learning with an integrated STEM Ethnoscience approach. From the results of the research and discussion, it can be concluded that (1) essential oil owners and workers have understood scientifically about the concept of essential oils, how to distill essential oils and their separation, knowledge of how to obtain good essential oil products, and calculate yield and loss of oil production volatile, (2) The learning model of essential oils with STEM approach integrated ethnoscience with project-based learning models was found, and (3) the results of the implementation of the essential oil learning model of the STEM approach integrated ethnoscience obtained positive responses and were able to improve student learning outcomes and experience.

1. Introduction

Indonesia as a tropical country that is rich in local plants for essential oil. The use of local plants as essential oil ingredients means conserving knowledge and experience on how to produce and develop essential oils of local products with national and international reputations. The community has known volatile oil that is found in certain parts of the plant and produces fragrant shoulders, but the community has not been able to provide a scientific explanation of the components and compounds that cause the fragrant odor. The definition of essential oil is volatile oil, because it contains volatile components in the leaves, flowers, skin, or fruit [1]. The community has accumulated a lot of

knowledge about plants that produce essential oils. The essential oils are widely known as volatile oils, such as flying oil, fuzzy oil, and perfume. The scientific explanation of essential oils is liquid compounds, which are obtained from parts of plants, roots, skin, stems, leaves, fruits, seeds and flowers by water distillation or steam distillation [2].

The community already knows various kinds of essential oils, which can be distinguished by the aroma because the compounds contained in essential oils are different and has distinctive aroma. The aroma of essential oils differ with one another and the difference in aroma depends on the type and intensity of aroma concentration for each constituent component. Organoleptically, the community has knowledge about the characteristics of essential oils, namely bitter taste, sometimes feels sharp, biting, gives the impression of warmth to heat, or even cold when it feels on the skin, depending on the type of constituent components. In a pure state, volatile oil easily evaporates at room temperature, unstable against environmental influences, such as oxygen in the air, sunlight and heat [3]. The results of the laboratory analysis for essential oils are active optics and rotate the polarization plane with a specific rotation, because it has an asymmetric C atom, and a high refractive index. The community currently utilizes essential oils for drugs, additives, and fragrances [4].

This research studied ethnics in the context of Science Technology Engineering Mathematics (STEM) for local essential oils. The local essential oil mentioned here is a product of local essential oil distillation in Indonesia which is traditionally produced using a very simple distillation device. Research related to essential oils was chosen, because essential oils are one of the topics of Organic Chemistry of Natural Materials. Referring to the Semester Program Plan on the Chemistry Education Curriculum, the topic of essential oils includes the definition of essential oils and examples, isolation techniques, identification of phytochemicals, structural tests and the number of essential oil components [5]. The next subject is the engineering of the main compounds in essential oils, as well as the calculation of the yield of essential oil products. In this study, a learning model of essential oil will be applied with the integration of STEM approach and ethnoscience, namely learning that emphasizes science, engineering technology and mathematics and integrated ethnoscience and is often called the Ethno-STEM approach [6, 7].

Although the Ethno-STEM approach has never been done by many lecturers, so learning natural organic chemistry feels less interesting and meaningful. This research is important, because the results of an analysis of the learning of Organic Chemistry in Natural Materials have been known that learning still emphasizes conceptual knowledge, so factual, procedural knowledge, and developing high-level thinking skills have not been developed. A learning model with an Ethno-STEM approach can be expected to be able to achieve all the expected competencies. In this study began with scientific scientific reconstruction related to local science-based essential oils, followed by the design of the essential oil learning model with integrated project ethno-science based learning models, as well as analysis of learning processes and results. The local essential oils used as research objects are clove oil, citronella oil, and patchouli oil which are traditionally produced in Boyolali, Central Java, Indonesia.

2. Methods

This type of research is a qualitative descriptive study of the construction of community science-based scientific science in the context of ethnics and STEM (Ethno-STEM) approaches. This approach was chosen with consideration to better understand the original knowledge of the community about the types of local plants, parts of plants, knowledge related to the process and the results of distillation of essential oils. In addition, the knowledge of oil refining workers is explored about how to identify essential oils, how to produce good quality products, handling waste, and operating profit of essential oils. To get information according to the purpose of the study, the informant selection technique uses purposive sampling. In accordance with the study focus, the research subjects were the owners and employees who worked at the essential oil refining in Kacurkan, Cepogo Subdistrict, Boyolali District, Central Java, Indonesia.

Data collection techniques through active participation observation, in-depth interviews with informants, field observations and documentation studies on the scope of essential oils. The starting point of the ethno-STEM approach is to describe people's knowledge, in this case essential oil refiners about the knowledge of essential oil distillation, techniques, creative ideas to produce the best essential oils, and the calculation of yield and profit and loss of local essential oil refining business. During interviews, resource persons' identities, technology and process engineering and essential oil products were recorded. Mathematical studies related to the amount of essential oil material, calculation of yield; and profit and loss studies. The collected data from observations and interviews were verified, reduced for data that did not contain scientific concepts, validated by experts on the scientific knowledge of Indegenous science into scientific knowledge, then validated by experts or scientific documents, followed by their application with integrated project-based ethnains learning models.

3. Results and Discussion

The following description presents the location documents, resource persons, and essential oil products presented in Figure 1 below.

Figure 1. Photographs of research locations, resource persons, and essential oil products

3.1. Science Reconstruction of Essential Oils in the context of STEM and Ethnoscience

Research observation and interview activities have been conducted on respondents in Cepogo, Boyolali Regency, Central Java. In the interview with Mr. Sadjimin (52 years old) and Mr. Eko (37 years old) said that the essential oil refiner in Jelok Village, Cepogo Subdistrict, Boyolali District had been going on for almost 23 years ago. The resource person said that the knowledge and skills of refining essential oils were inherited from ancestors, and instincts. Availability of raw materials for essential oils in certain seasons sometimes experience difficulties, for example raw materials for nilan, adas, betel, so that the oil production sometimes stops when the demand for these types of oil is high. The interview results also obtained information that the selling price of essential oils sometimes rose and also dropped, so the farmers stopped planting patchouli and turned to corn. Waginem (35 years old), a resident of Jelok, claimed that the last three months began planting patchouli on his 2,000-meter land because he saw a promising selling price. Currently every kilogram of wet patchouli is sold at Rp. 1,000, while dry patchouli is Rp. 4,000. In the study presented the results of interviews with resource persons and the results are presented in Table 1 below.

Table 1. The results of the recapitulation of the results of the interview with essential oil refinery owners and workers and their conceptualization in natural organic chemistry

No.	Focus on Questions and Answers from Resource Persons	Chemical content of scientific knowledge
1	**Question of Ethnoscience :** Please tell me where did you get knowledge about essential oil refining? **Answer** Knowledge and refining skills come from ancestors and lately I and my friends attended training from the service and visited several refineries. One of them is the distillation of clove leaf essential oil in Kendal. The place is already a large factory, only 1100 hectares of clove land.	Procedural knowledge about essential oil refining. In this section, questions related to science are knowledge and experience of essential oil refining
2	**Ethnoscience question: What ingredients are distilled to get the essential oil?** **Answer** Bengle, betel leaf, fennel seeds, kencur, clove leaves, almost all kinds of ingredients I have distilled, but the best results are bengle**.**	Materials and parts of plants that produce essential oils, which in the part of the plant contain essential oil components. This question is to reveal aspects of Science.
3	**Ethnomathematics question: How much material is used and the yield of essential oils obtained?** **Answer:** The most yield is Bengle oil, from 2.5 quintals obtained essential oil around 4.5-5 kg or about 6 liters depending on Bengle quality. The best Bengle in summer (not exposed to a lot of water). If nutmeg seeds are about 2 %, the leaves of Adas are about 2.5%, betel leaves 0.2% of the weight of the ingredients. Usually when the rainy season the amount of oil produced will decrease, but it is also difficult to get the ingredients. In the rainy season the oil yield was small, for the distillation of betel nut from 9 quintals only obtained about 1.1 kg of oil, but in	Composition of essential oil products. In this section the researcher wants to reveal the aspects of Mathematics related to the yield of essential oil products. In the study it was found that the content of essential oils depends on the season, water content, and age of the distilled material.

		the summer with the same amount of material the oil yield was more, about 1.5 kg.	
4		**Ethnotechnology question:** What is the process of refining essential oils? **Answer:** The material is put in a large furnace with a capacity of 8-9 quintals, the furnace must be closed tightly and fitted with a clamp, then steamed until the steam comes out. The amount of water used for steaming is adjusted to the container (there are already signs). Every 3 hours, the water used for steaming is refilled. The resulting steam will come out through a long pipe on the stove. The pipe connection is inserted in a cooling tub containing water (cooling spiral pipe). The stainless steel cooling pipe does not affect the oil. The oil vapor will condense, then it is collected in a container through the tap located at the end of the pipe. The results of distillation of essential oils [betel, bengkle, adas, and clove oil] are still in the form of a mixture of oil and water so it needs to be left to form a white layer. This layer is a barrier between betel oil and water, because betel oil is light oil, the oil will be on the water. The final result of the distillation is clear brown color, fragrant, and rather thick	This question is on the aspect of essential oil refining techniques. Distillation of essential oils traditionally through a distillation process by mixing the ingredients with water, or by steam distillation. The distillation process contains concepts and knowledge about changes in substance form, the concept of isolation, identification of an essential oil product. In this distillation process, the concept of density, separation of mixture is contained. There is a type of essential oil that is lower than water, but there is a higher level of water, which is the type of clove oil.
5		Ethno Engineering Question: How is the engineering of the refined waste? Is there engineering for the processing of essential oils? **Answer:** No one has processed refining waste into compost because most of the local residents already have manure, and are dried for fuel again. Betel leaf waste is used as a mixture of manure and taken by local residents. Waste is dry, dried and then sold for animal feed (cattle), the price is Rp 1000/kg and this price has been profitable.	In this section to reveal the character of conservation and entrepreneurship with reuse as animal feed, resale, make organic fertilizer, and return fuel. This section discusses the engineering aspects of handling waste from essential oils.

In the study, data and information analysis from the interview results were analyzed to be explained scientifically by referring to various literature, textbooks, articles, or information from experts and the results are presented in the table above. In this study scientific explanations from various experts and sources of information will be produced scientific knowledge that is conceptually correct. The results of the analysis from the interviewees 'answers found that learning that combines community knowledge with scientific knowledge is able to improve students' understanding of the concepts of science, technology, critical thinking, creative, logical and make learning more meaningful. the results of the observations are presented in Figure 2.

Figure 2. Photo documents for distillation equipment and essential oil products

In this study all documents, data from observations and interviews with owners and employees of oil refiners in Boyolali, Central Java, Indonesia, were then analyzed according to STEM aspects. The results of the research show that the techniques, methods and methods of refining essential oils are still the same as how the ancestors used to distill essential oils. Knowledge of essential oil refining technology obtained only based on its ancestors is known as ethnechnology [8, 9]. The results of the analysis of various literature and interviews with essential oils are also known that people use essential oils mostly as perfume, medicine, and use them to use them on the surface of the body/skin. Utilization of plants that contain essential oils as medicine. The resource person had the correct knowledge in producing essential oil product sharing, which in the distillation process contained the concept of isolation, identification, secondary metabolite compounds, and essential oil organoleptic test [2].

In the second phase of this research the design of integration and development of learning models of essential oils with Ethno-STEM approach. Referring to some literature related to the STEM approach, it was formulated that the STEM approach is a learning model that integrates science, technology, engineering, and mathematics in a learning [10]. STEM approach to grow the STEM workforce, as well as develop STEM literate citizens, and improve global competitiveness in science and technology and entrepreneurship innovation [11, 12]. In this study, from the results of the reconstruction of scientific science regarding essential oils, then integrated in the learning plan and teaching materials learning tools, and evaluation tools. The development of learning models for essential oils with ethno-STEM approach and learning tools after being designed and developed were validated by experts; after that it was applied in the study of essential oils. In this study a learning model of learning essential oils with integrated ethno-STEM project based learning has been designed. In the application of the essential oil learning model with an integrated STEM approach ethnoscience obtained positive responses and improved learning outcomes, conservation character and student entrepreneurship.

4. Conclusion

The results of the analysis from the research data from the resource persons and the discussion can be concluded that (1) the source of the owner and the essential oil refining workers have understood correctly according to the scientific knowledge regarding essential oils, essential oil refining methods, identification and how to obtain good essential oil products, and calculate the loss of production of essential oils. (2) the learning model of essential oils with STEM approach integrated ethnoscience with project-based learning models was found, and (3) the results of the implementation of the Model

STEM approach integrated ethnoscience model essential oil learning positive responses and were able to improve student learning outcomes and experience**.**

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