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DESIGN OF INQUIRY LEARNING MODEL INTEGRATED ETHNO-STEM FOR PROFILE ANALYZING THE AROMA COMPOUND FROM HERBAL TEA EXTRACT

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Abstract

The purpose of this research is to find a Design of an Inquiry Learning Model Integrated Ethno-Stem for Profile Analyzing the Aroma Compound from Herbal Tea Extract from tropical forest plants in Indonesia to accelerate student conservation literacy. This research is a basic research to find an Ethno-STEM integrated inquiry learning model and analysis of Aroma Compound

profiles of herbal tea extracts from tropical forest plants in Indonesia. The research was conducted at the Department of Chemistry in the Natural Materials course. The research subjects are UNNES chemistry education students for the 2021/2022 academic year. The research instruments were tests, questionnaires, observation sheets, and aroma compound profile test data for herbal teas from Indonesian tropical forest plants. Trapping of aroma compound compounds from herbal teas from tropical forest plants uses Arduino sensors type MQ-9, MQ135, TGS 2602, and 2620. The stage of Development of the Ethno-STEM Integrated Inquiry Learning Model usees the Analysis, Design, Development, and Implementation. The results of the research found an Ethno-STEM integrated inquiry learning model with the Sudarmin stages. The results of the analysis of aroma compound profiles from tropical forest plants are hydrogen, propane, carbon monoxide (CO), alcohol, carbon dioxide (CO_2), toluene, ammonia, acetone, heptane, and acid sulfide gas.

Keywords:

Inquiry, Ethno-STEM, Aroma Compound, Herbal Tea

1. Introduction

This research is a form of contribution to the realization of the vision and mission of the Universitas Negeri Semarang (UNNES) as a conservation-minded university with an international reputation. Innovative learning models that can realize the conservation character of students are important to find and develop. This research aims to find and develop an inquiry learning model design with ethnoscience and STEM (Ethno-STEM) rooted in the nation's culture and in accordance with the strategic planning of UNNES (Sudarmin et al, 2019; LPPM, 2020). This research is part of the output target of the Basic Research on Higher Education Excellence (Sudarmin et al, 2021).

This research was initiated by Sudarmin et al (2019) regarding the construction of science-based science for communities around tropical forests. Data collection was carried out through observation, interviews, and or online with an ethnoscience approach. The focus of questions related to public knowledge about ethnobotany, ethnomedicine, ethnopharmacology, and ethnoecology of tropical forest plants from Bajakah, Akar Kuning, taxus Sumatrana, and Sarang Semut. The results of data and information obtained from observations and interviews

were then reconstructed into scientific science and integrated as study material in the Natural Product course.

The urgency of the importance of this research is because the aroma compound test from herbal tea is a volatile secondary metabolite compound and is a characteristic of the aroma of local herbal teas in Indonesia and research like this has not been done much. In research, Volatil Organic Compound (VOC) as tea aromas are trapped using an electronic flavor sensor. This research refers to the successful use of the Genose electronic sensor for the detection of COVID-19 patients developed at UGM by Naputra et al (2022) and Ika et al (2020). The results of the analysis of several articles related to Aroma Compound sensor devices, it was found that this tool theoretically and procedurally in the future could be used as a detector of various Aroma Compounds in natural ingredients flavor, detection of cancer, tuberculosis, and respiratory tract infections (Urquiza et al, 2017; Sitohang, 2018). As for this research, in addition to finding the pattern of integration of the Inquiry Learning Model (MPI) with Ethno-STEM, it is also expected to find the output form of the Aroma Compound profile on herbal teas sold in the market and tropical forest herbal teas.

During the implementation of this research, Indonesia was stricken by the COVID-19 pandemic, so the research team decided that the implementation would be carried out online and offline. In this research, it is determined that the scientific reconstruction process based on community science will be carried out online, while the scientific explanation process to explain the types of Aroma compounds from herbal teas, is carried out through experimental inquiry activities in the laboratory. Herbal teas as research samples are herbal teas circulating in the market and herbal teas from tropical forest plants in Indonesia.

In the implementation of this Laboratory-based Ethno-STEM integrated inquiry learning, experimental activities to explain the profile of Aroma compounds were carried out at the UNNES Chemistry Laboratory while still applying the Health protocol. The application of integrated Ethno-STEM inquiry learning, which was carried out during the COVID-19 pandemic, is expected to be able to encourage students to be literate in technology, information data, and be able to hone reason and thinking. Students are able to apply their knowledge without constraints of time and location of learning (Sumarni & Sudarmin, 2019). Thus the integration of the inquiry learning model with Ethno-STEM can be applied according to the demands of this digital era.

The finding of Ethno-STEM integration in the inquiry learning model is interesting, because this approach can be used to facilitate students in conserving local wisdom, entrepreneurial character, higher-order thinking, and chemical literacy (Sandi-urena et al, 2012; Sudarmin et al, 2016). The important contribution of this research is (a) obtaining a prototype design of a typical Integrated Ethno-STEM inquiry learning model, as a form of contribution to the form of learning in realizing the vision of UNNES, (b) contributing to the development of knowledge regarding the profile of Aroma components from tea extracts of tropical forest plants in Indonesia. (c) Find an innovative learning model to accelerate the conservation character of students.

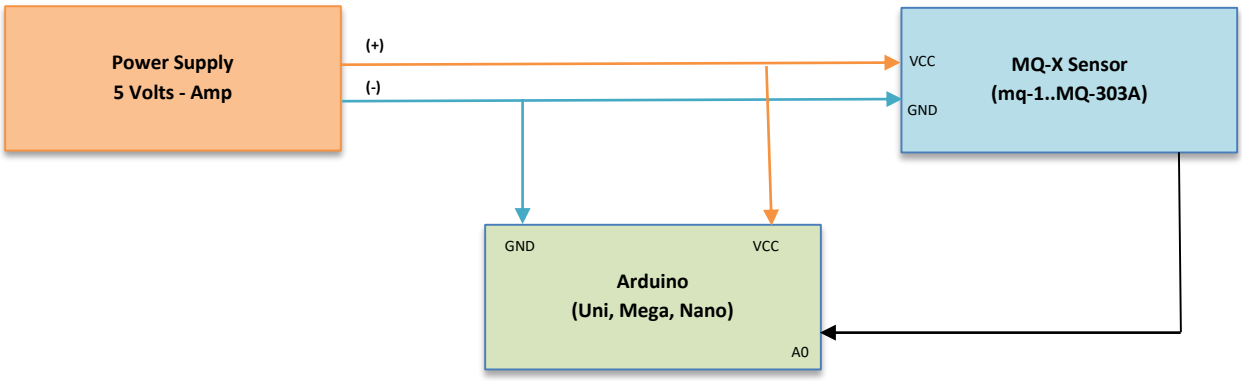
2. Research Method

This type of research is basic research to find an Ethnoscience and STEM (Ethno-STEM) integration inquiry learning model for Aroma Compound analysis study materials from extracts of various herbal teas from Indonesian tropical forest plants. The research was carried out on students majoring in chemistry education for the odd semester in 2021/2022. In the early stages of this research, an integration design was carried out between the inquiry model with Ethno-STEM and the learning stages. In this research, the pattern of integration between Ethnoscience and STEM according to Vølstad & Fogarty, (2006). In the next stage, designing a computer program and designing the Arduino sensor instrument design and testing the trapping of compounds, so that the display pattern and Aroma Compound content of various aromas of herbal teas and tropical Indonesian plants are produced. Research for the identification of VOCs was carried out at the Chemistry Laboratory of the Faculty of Mathematics and Natural Sciences, UNNES.

The materials and samples used in the research were four types of herbal teas from Indonesian Tropical Forest Plants which were made independently. The samples used in the form of extracts were four types of herbal teas, namely Bajakah tea, Akar Kuning, Taxus Sumatrana, and Sarang Semut. In this research, the Aroma Compound trapping process uses a series of sensors MQ-9, MQ135, TGS 2602, and 2620 integrated on Arduino and connected to a computer and run with the Arduino IDE application (Farooque et al, 2014; Handito et al, 2014). Experiment of trapping Aroma Compounds with electric sensors from various herbal teas from Indonesian tropical forest plants. The device and the process of trapping VOCs from herbal tea

samples are carried out as follows (a) determining the correct scheme and design of the sensor device design, (b) designing is ensuring that the circuit is correct by looking at the display results on the computer monitor screen using the Arduino IDE application, (c) build an Arduino IDE application script to run the sensor and Arduino circuits and read the data it outputs, (d) Arduino application scripts to connect the MQ and TGS sensors to the Arduino board and computer, (e) Calibrate the MQ and TGS sensors to measure the amount of gas contained.

Figure 1: *Schematic of the MQ-X Sensor Circuit with Arduino* (Own Illustration)



(Source: Self/Authors' Own Illustration)

3. Research Results and Discussion

3.1. Research Result

Results of Ethno-STEM Integration Inquiry Learning Model Development. In research, the inquiry learning model was developed referring to Wenning (2012). The inquiry model is able to encourage students to generate insights and innovative ideas, develop thinking, emotional, and psychomotor abilities (Sumarni et al, 2018). In this research, an Ethno-STEM integrated inquiry learning model has been designed and developed with the *SUDARMIN* syntax (Sudarmin et al, 2019), namely:

1. Serve. Lecturers ask questions or problems regarding interesting issues regarding Indonesian tropical forest plants. Why tropical forests are plants capable of efficacious immunity, and anticancer; and what Aroma compounds are contained in the herbal tea?
2. Performance Works and Exploration. Students carry out observation or exploration activities independently or in groups on various references, articles, and digital literature to answer problems posed by lecturers and continue to develop hypotheses. In this activity, students are also expected to seek information about the components of Aroma compounds in herbal tea extracts from tropical forest plants in Indonesia.

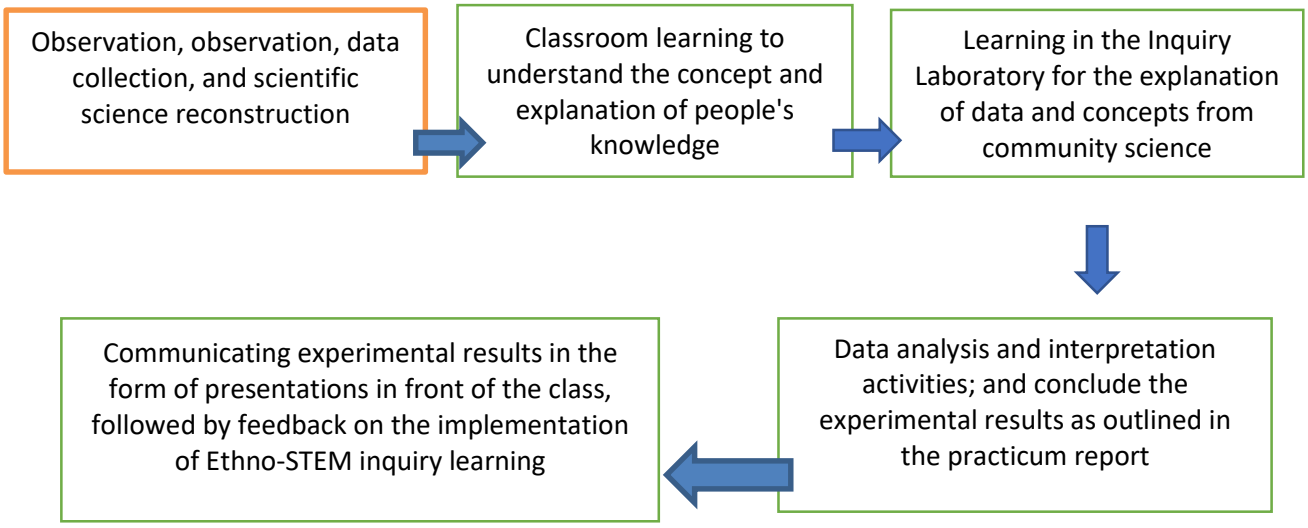
3. Discuss. Students after their performance record the findings of temporary answers (hypotheses). In the discussion, the students conveyed their exploration of the answers to problems from the lecturer. In this activity, students also discussed experimental designs regarding testing the Aroma components of Indonesian herbal teas and designing herbal tea-making devices that were integrated with Aroma Compound sensors.
4. Analyze and propose hypotheses. At this stage, re-analyze the design of the learning model and the design of the herbal tea maker integrated with the Aroma Compound sensor. In this activity, an analysis related to the implementation of inquiry experiments was also carried out to prove public knowledge that tropical forest tea has immune, anticancer, and antioxidant properties.
5. Design the implementation of the experiment. At this stage, group discussions were conducted to determine the time of the study and preparation of materials and experimental equipment.
6. Establish the trial design and trial schedule. The lecturer provided input from the results of student presentations regarding the schedule and readiness for experimental analysis of Aroma compounds from extracts of Indonesian tropical forest plants. At this stage, each group of students receives feedback regarding the accuracy of the tools and equipment used.
7. Implement. In this phase, students in groups apply learning models and the application of inquiry practicum on the analysis of Aroma Compound analysis in Indonesian tropical forest herbal teas.
8. Assess, evaluate, and conclude. After testing the Aroma Compounds of herbal tea extracts from Indonesian tropical forest plants, students analyzed the data, trying to draw conclusions about Aroma Compounds in Indonesian tropical forest herbal tea extracts; as well as to test the truth of the hypotheses that have been made.

3.2. Discussion: Implementation of the Ethno-STEM Integrated Inquiry Learning Model

The implementation of the Ethno-STEM Integrated Inquiry learning activity is designed through online learning by applying the Zoom application for study materials regarding (a) the nature of inquiry learning and its syntax, (b) the diversity of secondary metabolites and their characteristics, (c) the study of herbal teas and Volatile Organic Compounds asa Aroma Compound, as well as the process of trapping it with sensory devices. While offline (face-to-

face) activities, students conducted extraction and maceration experiments on the main components of herbal teas with organic solvents, phytochemical tests, and experimental Aroma Compound analysis of extracts of herbal tea and tropical forest samples using Aroma Compound trap sensors. In general, the activities of implementing Ethno-STEM integrated inquiry learning concerning Wenning (2012) are presented in Figure 2.

Figure 2: *Stages of Implementation of the Ethno-STEM Integrated Inquiry Learning* (Own Illustration)



(Source: Self/Authors' Own Illustration)

The data captured from the computer monitor screen is first saved in Docx document format, then converted into a table, and then copied to Excel for processing. The data in Appendix 1 is already in. After reading the blank data is stable, then it is replaced with samples that have been prepared. Some of the data from the reading of Aroma Compound content in tea by the TGS sensor can be seen in Table 1. The data captured from the computer monitor screen is stored in. docx document format, then converted into a table, and can be copied to Excel for processing.

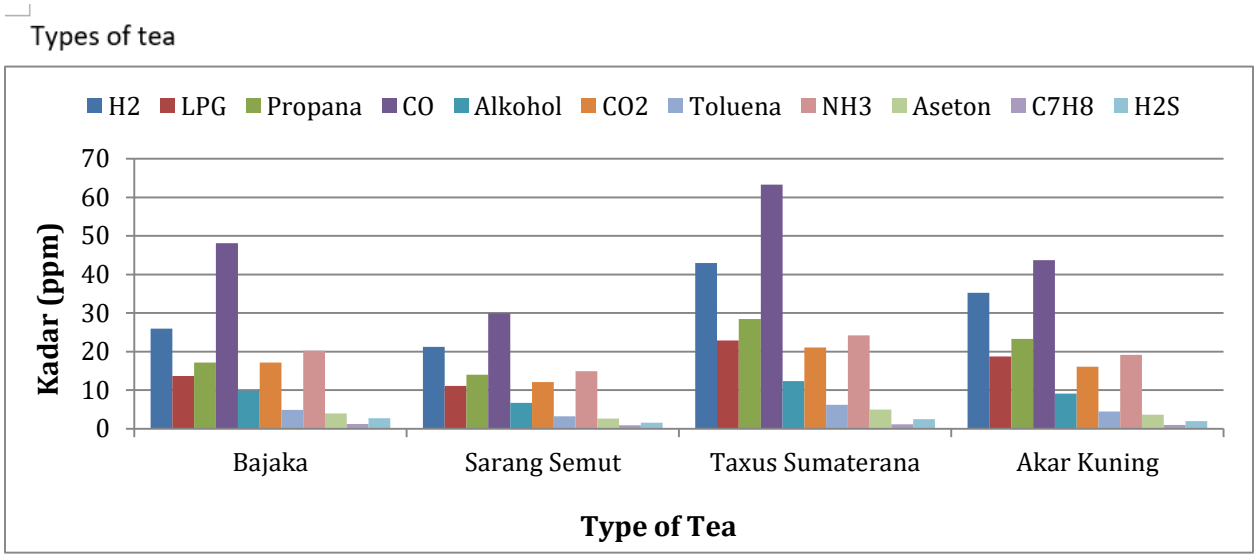
Table 1: *Average Sensor Measurements MQ2, MQ135, and TGS 2602 (In Ppm) (Own Illustration)*

Sample	1	2	3	4	5	6	7	8	9	10	11
Blanko	8,99	4,59	5,92	3,67	1,25	2,70	0,52	4,13	0,44	0,08	0,02
Bajakah	25,94	13,65	17,12	48,14	9,82	17,13	4,84	20,25	3,92	1,18	2,71
Sarang	21,25	11,11	14,02	29,92	6,66	12,05	3,18	14,92	2,60	0,84	1,51

semut											
Taxus	42,96	22,91	28,40	63,26	12,30	21,03	6,17	24,23	4,97	1,10	2,46
Akar kuning	35,23	18,68	23,27	43,72	9,11	16,03	4,46	19,15	3,62	0,96	1,95

(Source: Self/Authors' Own Illustration)

Figure 3: *Profile of Aroma Compound Compounds in Indonesian Tropical Forest Plant Herbal Teas Detected With MQ2, MQ135, and TGS 2602 Sensors* (Own Illustration)



(Source: Self/Authors' Own Illustration)

4. Closing

The results of the research concluded that: (1) The design of the Ethno-STEM integrated inquiry learning model that has been developed and applied for the study of herbal tea aroma compounds is the SUDARMIN Model, (2) The compounds from the aroma of herbal tea from tropical forest plants that are trapped by the Arduino gas sensor are: hydrogen gas, Liquified Petroleum Gas, Propane, , Carbon Oxide, Alcohol, Carbon Dioxide, toluene, ammonia, asset, heptane, and sulfide acid gas.

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