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Implementation of Inquiry Model Integrated Ethno-STEM On Volatile Organic Compounds (VOC) Herbal Tea for Downstreaming the Brilliance of UNNES Education and Student Conservation Character.

S. Sudarmin*, K. Kasmui, S. Diliarosta, W. Sumarni, and Rr. S.E Pujiastuti

Lecture of Chemestry Education- Universitas Negeri Semarang, Semarang, Indonesia

*) Corresponding Author: sudarmin@mail.unnes.ac.id

Abstract. The purpose of this study was to determine students' responses to the application of the integrated Ethno-STEM inquiry learning model for volatile organic compounds from herbal teas and mastery of the concept of learning outcomes in ethnoscience and local wisdom. This research is part of research funding expertise research for the 2023 fiscal year. The research begins in 2022 by (1) developing an ethno-STEM integrated inquiry learning model with Sudarmin syntax through the define, design, and development stages, (2) preparing research instruments for students' responses to Ethno-STEM integrated inquiry learning model for study materials of volatile organic compounds in herbal teas. In this study, data was collected related to the Ethno-STEM integrated inquiry learning model that had been developed. The research subjects were science education students taking Ethnoscience and Local Crafts courses at the Faculty of Mathematics and Natural Sciences (FMIPA) Semarang State University. At the end of the implementation of the Ethno-STEM integrated inquiry learning model with the Sudarmin syntax, data analysis of student responses to the learning process and outcomes was carried out. The results of the study concluded (a) students' concept mastery scores still needed to be improved, because based on the N-gain score there were still many moderate categories, (b) understanding of organic volatile compounds in herbal teas, trapping tools for organic volatile compounds from herbal teas reached a good category, (c) The overall results of learning activities show a positive response to the developed model

Keywords: Inquiry Learning Model; Downstreaming; Ethno-STEM; Conservation

INTRODUCTION

This research is important, because currently the vision and mission of Universitas Negeri Semarang (UNNES) has changed, namely to Become a World-Reputed University and a Pioneer of Educational Brilliance with a Conservation Insight, so that all academics are obliged to realize the Vision and mission of UNNES (UNNES, 2022). This research is a form of contribution to realizing the vision and mission of UNNES as a world-reputed university and as a pioneer of educational excellence education with a conservation perspective. This research aims to downstream the brilliance of the education sector in the form of an innovative learning model in the form of an Ethno-STEM-integrated inquiry model that is able to realize the character of conservation in the topic of volatile organic compounds (VOCs) from the aroma of Indonesian local herbal teas. The Ethno-STEM integrated inquiry learning model is a learning model designed and developed by Sudarmin et al (2020). This learning model is able to develop students' thinking skills, mastery of concepts, as well as scientific characters and attitudes in students (Wening, 2011, Sudarmin et al, 2021, Sumarni W, et al, 2021)).

Thus the research background refers to the Vision and Mission of UNNES for 2020 – 2024 and is a priority program for UNNES to realize the brilliance of the field of Education [1], meaning that UNNES is a reference and excels in the field of Education. The problem is that there are not many examples to realize the UNNES Vision regarding the brilliance of the Education sector. This downstream expertise research is also motivated by the expertise and research track record of Sudarmin et al for 12 years, resulting in expertise in the field of ethnoscience, with expert works presented in references and Sudarmin et al's roadmap presented in references [2] to references [24]. This research is interesting, because Sudarmin et al have designed an Ethno-STEM and inquiry approach that is able to provide conservation characters [18] and [24]. Sudarmin et al (15) and [21] have designed the design of a VOC sensor tool for tropical forest

herbal teas and currently the tool is being filed for a simple patent in 2021. The urgency of this expert research is to realize the brilliance of UNNES in the field of education regarding the findings of innovative learning models namely the Ethno-STEM MPI which has been recognized and cited by researchers and article writers in National and International Journals [13], while the research and findings of the VOCs tracer tool on the Aroma of Indonesian Tropical Forest Herbal Tea have not been widely studied, so this research is a form of new discovery.

This research is important, because at this time the conservation character in the academic community is the realization of the vision and mission of Universitas Negeri Semarang as a conservation-minded university with international reputation (UNNES, 2019). Thus, this research is a form of contribution to the realization of the vision and mission of the UNNES as a conservation-minded university with an international reputation. Therefore, an innovative learning model that is able to realize the conservation character of students is important to find and develop, and one of them is the Ethno-STEM integrated inquiry learning model. The inquiry learning model is a learning model that is able to develop students' thinking skills, mastery of concepts, and students' scientific character and attitude (Wening, 2011, Damayanti et al, 2017, Sudarmin et al, 2021, Sumarni W, et al, 2021)).

Research as part of superior basic research in higher education with the title of Ethno-STEM integrated inquiry learning model design, secondary metabolite bioactivity study material to accelerate student conservation character. Thus, the purpose of this research is to analyze the mastery of students' mastery of conservation concepts and characters. This research has been started in 2021 by (1) developing an ethno-STEM integrated inquiry learning model with the Sudarmin syntax through the define, design, and development stages, (2) preparing research instruments for mastering organic chemistry concepts and conservation characters which will then be validated. This research is important to do, because the results of the analysis on the mastery of the concept of secondary metabolites in students and conservation characters still need to be developed and improved.

In this study, solutions were applied to improve conceptual mastery and provision of conservation characters through the application of previous research outputs related to the Ethno-STEM integrated inquiry learning model with the *Sudarmin* syntax (Sudarmin et al, 2022). This research is interdisipliner with purpose apply the Ethno-STEM integrated inquiry learning model and how it affects students' mastery of concepts and conservation characters. This research also analyzes student responses to the learning that has been done. In this research, data collection on the mastery of conservation concepts and characters was carried out with the help of the Google Form application, because during the implementation of this research, the COVID-19 pandemic outbreak had not disappeared.

The application of learning with the Ethno-STEM integrated inquiry learning model is carried out on research subjects of chemical education students of the Faculty of Mathematics and Natural Sciences (FMIPA) Universitas Negeri Semarang for the 2021/2022 academic year. At the end of the application of the Ethno-STEM integrated inquiry learning model with the Sudarmin syntax, a test of mastery of chemical concepts and conservation characters was given, the data on the mastery of conservation concept and character test data obtained were analyzed for the student's test scores and conservation character. In this research, the character of conservation is analyzed by analyzing the response data and knowledge of the conservation character of the students. At the end of the application of the Ethno-STEM integrated inquiry learning model, focus group discussion (FGD) activities were carried out for improvement, continued by disseminating research results, so that valid and feasible ethno-STEM integrated inquiry learning tools were produced. The success of this research will be beneficial for the development of science, technology, as well as for the community to gain knowledge about the health benefits of tropical forest plants.

METHOD

This research was started in 2021 by Sudarmin et al (2021) developing an ethno-STEM integrated inquiry learning model with Sudarmin syntax through the definition, design, and development stages, preparing research instruments to measure students' mastery of concepts regarding secondary metabolites and conservation characteristics. In this study an ethno-STEM integrated inquiry learning model with Sudarmin syntax will be applied to the topic of organic volatile compounds from the aroma of

local Indonesian herbal teas and how they affect the character of student conservation and student responses to the application of the learning model that has been developed.

The subjects of this study were students of science and chemistry education at the Faculty of Mathematics and Natural Sciences (FMIPA) UNNES with a total of 69 students for the 2022 and 2023 academic years. The implementation of the Sudarmin ethno-STEM syntax integrated inquiry learning model was carried out in eight meetings. At the beginning and end of the implementation of the Ethno-STEM integrated inquiry learning model, tests were carried out on concept mastery, character conservation, and student responses to the developed learning model. Research data were analyzed by N-gain and qualitative description. In this research, the results of the data in the form of concept mastery scores, conservation characteristics, and student responses obtained were analyzed and interpreted, so that the level of learning achievement can be determined.

RESULTS AND DISCUSSION

1. Design of Inquiry Models Integrated Ethno-STEM Integrated *Sudarmin* Syntax.

The implementation of the Sintak Sudarmin Integrated Ethno-STEM Inquiry learning model is designed through online learning with zoom meeting and offline applications. The research subjects were students of chemistry and science education for topics and themes concerning (a) the nature of inquiry learning in the Wenning model and its syntax, (b) the diversity of local herbal teas and their method of preparation, secondary metabolites and volatile organic compounds, (c) analysis of articles related to the content of volatile compounds in various herbal tea aromas and their characteristics, (d) introduction of work procedures for experiments on the analysis of organic volatile compounds through an integrated herbal tea maker sensor for herbal tea aroma compounds (results of research by Sudarmin et al, 2020, 202, and 2022).

While offline learning activities are carried out by students in experimental activities for trapping volatile compounds in the aroma of herbal teas with a VOC trap tool from the aroma of local herbal teas. The herbal teas used as samples in this research were bajakah tea, root kuning, ant nest, and taxus sumatrana. Practical activities were carried out in two group meetings for testing and analysis of volatile compounds in herbal teas with a local herbal tea maker integrated with the Aroma sensor of herbal tea from the Arduino sensor. The activity of analyzing volatile compounds in the aroma of herbal tea as an activity is downstreaming the interactive demonstrative type Ethno-STEM integrated inquiry learning model. In general, the implementation of Ethno-STEM integrated inquiry learning activities in research refers to Wenning (2011) and Kidman, G (2017), where the inquiry learning model that was derived and applied to this research is presented in Figure 1.

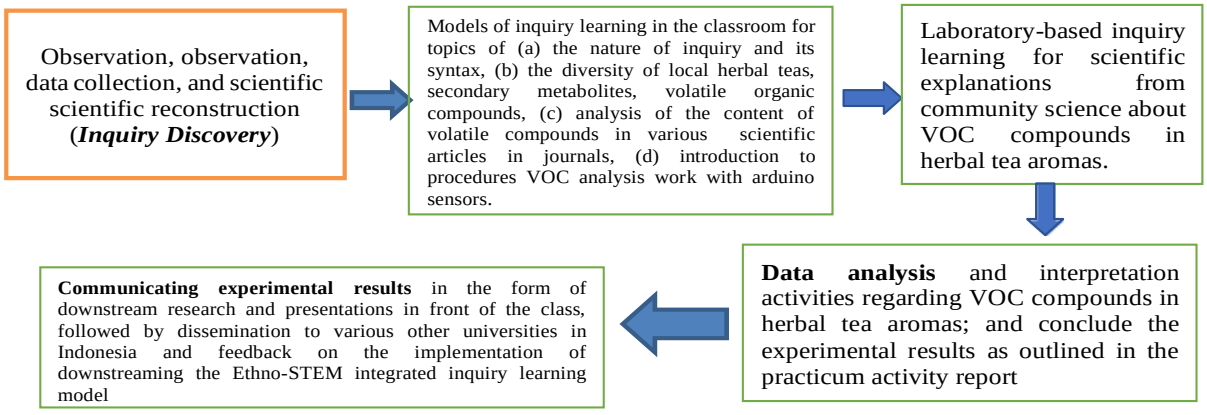

Figure 1. Stages of downstream implementation of inquiry learningmodel Integrated Ethno-STEM

The downstream activity of the Ethno-STEM integrated inquiry learning model, the topic of herbal tea VOC compounds from Indonesian tropical forest plants with Sudarmin syntax, the stages are as follows:

1. **Serve [S**]. Lecturers ask questions or problems from interesting issues related to the habit of drinking tea and coffee, and which one is more interesting, the aroma of herbal tea or coffee, and what VOC compounds are found in

the aroma of herbal tea from tropical forest plants?

2. **Performance [U]**. Students carry out observation activities independently or in groups, seek information from digital-based sources or references, books, and articles to answer problems from lecturers or develop hypotheses. In this research activity students are also expected to find information about what components of VOC compounds are present in herbal tea extracts.

3. **Discuss [D]** : At this stage, students carry out discussion activities in groups to convey the results of exploration and identification regarding the profile of VOC compounds in herbal tea extracts. In this activity, students discussed experimental designs on testing the VOC component of Indonesian herbal teas in groups and designed a herbal tea maker that was integrated with a VOC sensor.

4. **Analysis [A]** and submit a tool for the trial test of VOC compounds from herbal teas of tropical forest plants. At this stage, it is necessary to re-analyze whether the proposed VOC sensor integrated herbal tea maker design has been supported by accurate and good references, so that the experimental design proposed is conceptually correct and convincing that it can be implemented properly.

5. **Design [R]** schedule of inquiry trials. Group discussions were held to determine the time to carry out the research, to prepare the need for materials and experimental tools or inquiry to test Voltil Organic Compound from Indonesian tropical forest plants. At this stage, the draft schedule of inquiry activities for the manufacture of herbal teas and the entrapment and analysis of volatile organic compounds (VOCs).

6. **Establish [M]** trial design and trial schedule. Lecturers provide input from the results of student presentations, and lecturers communicatively suggest improvements to experiments and VOC tests for herbal tea aromas and research time regarding VOC analysis of tropical forest plants.

7. **Implement [I]**. In this phase, students in groups apply an inquiry experimental design regarding the analytical test of VOC compounds in Indonesian tropical forest herbal teas. Students in groups are also required to collect experimental data and information about the various types of VOC herbal teas that have been determined.

8. **Assess, evaluate, and conclude [N**]. In this research, after students tested the VOC aroma of herbal tea from Indonesian tropical forest plants, they tried to draw conclusions about the diversity of VOC aroma of herbal tea from Indonesian tropical forest plants and at the same time to test the truth of the hypotheses that had been prepared or proposed previously.

2. Result of VOC trapping experiments of various herbal teas

The initial steps in designing Arduino sensor-based digital instruments are (a) determining the correct schematic and sensor 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) building Arduino IDE application script to run the sensor and Arduino circuits and read the data they output, (d) Arduino application scripts to connect the MQ and TGS sensors with the Arduino board and computer, (e) Calibrate the MQ and TGS sensors in measuring the actual amount of gas content. The important thing that must be considered in preparing this Arduino application script is that the results or output that appears on the monitor screen can be captured as text to be processed as a Word document and can be converted into an Excel document so that it is easier to process and analyze. In this research the methods and steps are taken to capture text directly from the readings of the Arduino MQ and TGS sensors, because readings are made every 0.5 seconds for 2 minutes, so that each sample produces a VOC profile or data.

Table 1. Average MQ2, MQ135, and TGS 2602 sensor measurements (in ppm)

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 semut	21.25	11.11	14.02	29.92	6.66	12.05	3.18	14.92	2.60	0.84	1.51
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

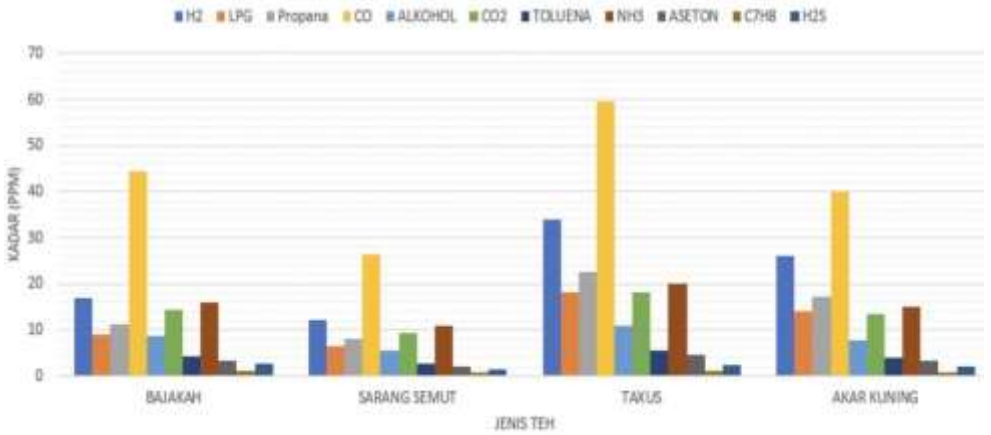

Figure 2. VOCc composition of various Tropical Forest Plant herbal teas detected byMQ2, MQ135, and TGS 2602 sensor

The effect of implementing MPI Integrated Ethno-STEM on concept mastery. In this research, an analysis of the influence of the application of the Ethno-STEM Integrated Inquiry Learning Model on the Mastery of Conservation Concepts and Characters was carried out. The results of the concept mastery data analysis, after analyzing the pretest and posttest scores are presented in Table 2.

Table 2. Results of Concept Mastery Recap After Learning Integrated Ethno-STEM Inquiry with Sudarmin's syntax.

No	Score Level N-gain	Amount (person)	Score category N-gain	Percentage (%)
01.	0.71 – 1.00	4	high	0,13
02.	0.41 - 0.70	19	medium	0.59
03.	0.00- 1.40	9	low	0.28

The results of this research show that the implementation of the Ethno-STEM integrated inquiry learning with the Sudarmin syntax has been effective and is able to significantly improve learning achievement.

3. Response to the Implementation of the Inquiry Model Integrated Ethno-STEM

. Student responses after learning are known to students (a) have understood the meaning of ethnoscience (96.50%), (b) have known the inquiry model (84.20%). (c) understand the syntax of the inquiry model (73.70%), (d) recognize the STEM approach (78.90%), (e) understand the syntax of integrated inquiry learning ethno-STEM (84.20%), (f) know and know tropical forest plants (98.20%), (g) understand the characteristics of tropical forest plants (86%), (h) understand the health benefits of some tropical forest plants (96.50%), (i) feel interested in the ethno-STEM integrated inquiry learning model lecture (94.70%). Based on the results of student responses, the ethno-Stem integrated inquiry learning model received a positive response from students.

CONCLUSION

The results of the study concluded that: (1) Ethno-STEM integrated inquiry model for the topic of volatile organic compounds (VOCs) of herbal teas from tropical forest plants as a downstream of the brilliance of UNNES education with SUDARMIN syntax, (2) Results of VOCs analysis of the aroma of herbal teas of tropical forest plants with Arduino sensors identified as hydrogen, LPG, propane, carbon monoxide, alcohol, carbon dioxide, toluene, ammonia, acetone, heptane, and sulfuric acid gas. (3) Student responses to the inquiry learning integrated Ethno-STEM developed received a very good response and students increased conservation literacy and UNNES Vision brilliance

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