



Reconstruction of The Ethno-STEM Integrated Inquiry -Based Project Learning Model (Ethno-STEM IBPjLM) for the Topic of Herbal Tea Aroma Compounds as Global Local Wisdom

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Abstract. The aim of this research is to reconstruct an Ethno-STEM integrated inquiry-based project learning model (Ethno-STEM IBPjLM) on the topic of herbal tea aroma as global wisdom. This research includes qualitative descriptive research. The research focus includes (a) the process of reconstructing the community's indigenous knowledge into scientific knowledge related to ngeteh culture, (b) reconstructing the Ethno-STEM IBPjLM design on the topic of Herbal Tea Aroma, (c) identifying the constituents of herbal tea aroma using an Arduino gas sensor, (d) student responses towards the application of Ethno-STEM IBPjLM on the topic of herbal tea aroma. The qualitative approach includes activities (a) collecting Ngeteh cultural data, data reduction and validation, scientific reconstruction, and its integration in Ethno-STEM IBPjLM, (b) identification of tea volatile compounds using an Arduino gas sensor. Based on the results of the research and discussion, it was concluded that (1) scientific concepts in culture had been found, such as the concept of global local wisdom, maceration, extraction and bioactivity of tea aroma compounds, (2) the reconstruction model between IBPjLM and Ethno-STEM was found to be an Integrated model, and (3) volatile tea compounds have been identified, namely CO, CO₂, and NH₃, ethanol, and LPG which are trapped by the Arduino gas sensor, (4) students' positive responses to tea culture, global local wisdom, and Ethno-STEM IBPjLM have been interesting.

Keywords: Reconstruction, inquiry-based Project Learning Model, Ethno-STEM, local wisdom.

1. Introduction

Local wisdom is a characteristic of ethics and cultural values in society that is passed down from generation to generation [1]. However, in this era of globalization, there are many impacts that have led to changes in people's lifestyles from typical or cultural values as local wisdom to modern ones. Meanwhile, the meaning of globalization can be interpreted as a process in which everyone in the world is bound to each other and borders [2]. Thus, the character of global local wisdom is an effort to always maintain values, culture, ethics and natural resources to remain sustainable amidst the influence of globalization. The character of global local wisdom is very much in line with the vision and mission of Universitas Negeri Semarang (UNNES), namely to become a university with a conservation perspective, which means conserving the local wisdom of the Indonesian nation in the midst of this era of globalization. Apart from that, UNNES aims to become a pioneer in the field of education and have a world reputation [3].

The object of this research is related to global local wisdom regarding Ngeteh culture, tea aroma, conservation of secondary metabolite compounds that are beneficial for health and life from tropical forest plants and local plants as herbal tea. The potential of Indonesia's tropical forests must be cared for so that the benefits can be felt by future generations. The character of caring for the surrounding natural environment needs to be instilled from an early age, especially through education and learning at universities. Thus, this research aims to find and develop an innovative learning model design to instill the character of global local wisdom of ngeteh culture and herbal tea plants and Indonesian tropical forest plants

The discovery of an innovative learning model design to instill tea culture, global local wisdom, and important conservation research; because it is UNNES' flagship research. Due to this, this research focuses on reconstructing the Ethno-STEM IBPjLM STEM design on the topic of herbal tea aroma to equip students with local and global wisdom characters. The topic used as the object of inquiry in this research is the aroma of herbal tea as a form of local wisdom from the secondary metabolite compounds contained therein and the culture of ngetek or drinking tea. The IBPjLM Ethno-STEM design reconstruction can provide inquiry experiences through the scientific work of extraction, isolation and phytochemical analysis; as well as testing the volatile compounds of herbal tea aroma. The focus of this research is related to tea culture, because tea culture is a form of local Indonesian and global wisdom. Ngeteh culture is a staple drink for Indonesians, while it can be served in cups, clay glasses, cold, warm, sweet or plain [4].

This research began with research on the scientific reconstruction of tea drinking culture and student responses to tea drinking culture, followed by design reconstruction from Ethno-STEM IBPjLM for the topic of herbal tea aroma. The next research is a scientific explanation of the diversity and analysis of volatile compounds from the aroma of herbal tea using an Arduino gas sensor connected to a computer processing device. With the development and application of the Ethno-STEM design, IBPjLM can foster a sense of care and character of global local wisdom in students

regarding tea culture and care for the local wisdom of herbal tea and tea from Indonesian tropical forest plants.

The urgency of this research is as an effort to realize the UNNES priority program for 2024-2028, namely to realize excellence in the field of education, especially in the field of conservation education. Therefore, the discovery of the IBPjLM Ethno-STEM design and the Volatile Compound Tracer Tool from the Aroma of Indonesian Herbal Tea is a form of UNNES excellence in the field of education. Sudarmin et al [5-6] have found a conceptual framework for reconstructing scientific science based on community knowledge and developing an ethnoscience-based science learning model. Expertise on herbal tea making tools and herbal tea volatile compound tracers is one of the innovative findings, because search results at the Intellectual Property Data Center (PDKI) for these tools have not been found and registered [7].

The results of the analysis regarding the identification of various world teas and herbal tea aroma compounds using gas chromatography have been carried out by researchers and are presented in references [8-10]. Meanwhile, identification and tracing of tea aroma volatile compounds using an Arduino gas sensor has never been found; So the findings of Sudarmin et al [11] are innovative findings and are currently in the application stage to obtain a simple patent [12]. Volatile compound gas sensor devices that will be applied in this research include Arduino AT Mega 328, TGS 2602, TGS 2620 and Nebulizer.

This research is also supported by the track record of several studies from Sudarmin et al [13-16] which have been published in research reports and scientific articles regarding ethnoscience research in developing conservation, scientific literacy and the character of global local wisdom. Sudarmin et al [17] found that the ethno-ESD integrated model of inquiry (MPI) was able to develop students' green chemistry character. Another reason why it is important to carry out this research is (a) Currently, in higher education accreditation, it is often discussed as a typical model for conservation character education at UNNES, (b) The importance of conserving local biodiversity as a basic ingredient for herbal tea which is beneficial for health and society, (c) there has not been much research to properly understand what tea is, why tea tastes bitter, as well as the volatile aroma compounds of herbal tea and their benefits for life.

2. Methods

2.1 Types, Procedures and Focus of Research

This type of research is mixed research [18-19], namely descriptive qualitative research for data resulting from scientific reconstruction regarding ngeteh culture in the Ethno-STEM context. Meanwhile, the quantitative data for the type of inquiry experimental data is for analyzing the aroma constituents of herbal tea using the Arduino gas sensor designed by Sudarmin et al (16). The research instruments are interview sheets, questionnaires and observations related to tea drinking culture, tea aroma with Ethno-STEM content and context.

This research procedure is (a) research related to scientific reconstruction regarding tea culture, (b) reconstruction research on the IBPjLM Ethno-STEM design and design of volatile compound tracer tools for Indonesian and global herbal teas, and (c) application of IBPjLM Ethno-STEM to chemistry education students, and (d) analysis of student responses regarding drinking culture and the application of Ethno-STEM IBPjLM. The stages in the reconstruction of the IBPjLM Ethno-STEM design on the topic of herbal tea aroma to embody the students' global wisdom character are as follows:

1. Preparation through coordination and collaboration with the research team through focus group discussion activities regarding shared perceptions between the research team.
2. Strengthening the program through focus group discussions, and questions and answers between the research team to find agreement in designing reconstruction products from Ethno-STEM IBPjLM, learning tools, and implementation for applications from on the Ethno-STEM IBPjLM topic of Herbal Tea Aroma and gas sensor tracer tools Arduino for identification of aroma volatile compounds of Indonesian herbal tea,
3. Preparation of materials and learning tools through coordination and consolidation activities to discuss duties and responsibilities for preparing tools and materials, as well as a schedule for the research team in downstreaming the application of Ethno-STEM IBPjLM and the application of herbal tea volatile compound tracer tools to students.
4. Implementation and analysis of responses from (a) IBPjLM Ethno-STEM design reconstruction products on the topic of herbal tea aroma compounds and (b) implementation of experiments on trapping and identification of herbal tea aroma volatile compounds using an Arduino gas sensor for students.

2.2. Analysis and Identification of Herbal Tea Aroma Volatile Compounds

The equipment used to identify the volatile compound content of herbal tea is a series of sensors MQ-9 and MQ135 and TGS 2602 and 2620 integrated with Arduino which are connected to a computer and the Arduino IDE application. The tool design and operational steps are as follows: (1) The initial design is to assemble the sensor on the "Breadboard" board using jumper cables connected to the address that corresponds to the Arduino type, (2) Create an Arduino program on the computer according to the sensor that will be measured using the application Arduino IDE, (3) connects the Arduino-sensor circuit to the computer, (4) Prepares samples of brewed tea for each type and brand of tea, brews until evaporates, then places it under the sensor to measure the volatile compound content., (5) Runs the Arduino IDE application on the computer to read data via sensors connected to Arduino. Each data reading always begins with instrument calibration, after that the sample data is read, (6) Data reading is carried out at 1 (one) second data or half a second interval for two minutes until stable and accurate data is obtained. In this research, the type of data taken is according to the capabilities of each sensor, (7) The data reading will appear on the computer monitor screen, after completing the reading of each sample it is then copied and transferred to a document

(Word), (8) The Word document data is then converted to Excel data so that it is easy to analyze statistically and graphically.

2.3. Research Instruments and Data Analysis

The research instruments used in this research are observation sheets, questionnaires, questionnaires and data justification to determine the suitability of implementation with the research design referring to reference [12]. The research instrument to measure student responses to the application of Ethno-STEM IBPjLM herbal tea aroma used a questionnaire instrument. Meanwhile, aata analysis was carried out using qualitative and quantitative descriptions based on the type of data obtained in the research.

3 Results and Discussions

3.1 Scientific Reconstruction of Ngeteh Culture and Tea Aroma

This research was conducted through interviews with resource persons who sell tea and coffee drinks at a shop in the Kerinci area, Jambi Region. The resource person is Feri (35 years old) who has experience as a tea seller for two years. His parents acquired the knowledge of making and selling tea, namely selling kawo powder tea (coffee leaf tea) which is a traditional drink typical of the Kerinci people. The making of this tea is quite unique, namely that the coffee leaves are dried by smoking them until they are dry, then brewing them in a coconut shell. The results of the interview and scientific reconstruction are presented in Table 1.

Table 1. Results of interviews with Tea Makers regarding the culture of drinking tea and coffee, how to make it, the aroma of tea and coffee and their benefits.

No	Question	Indigenous knowledge of community
1	What do you think about tea and ngeteh?	Tea is a typical drink for Indonesian people, especially fathers drink it in the morning before work or in the afternoon after working in the rice fields.
2	Can tea also reduce drowsiness like drinking a glass of coffee?	I don't think so, the feeling of drowsiness remains after drinking tea, but if you drink coffee it can be reduced.
3	What is the benefit of drinking tea and coffee for health?	As far as I know, coffee is to relieve drowsiness and calm the mind. Tea makes the body fresher and quenches thirst
4	Why tea or coffee has an aroma?	Because water vapor carries the aroma that comes out of coffee and tea when brewed with hot water
5	How do you make the best coffee and tea, so they give off a distinctive aroma?	Brewed with hot water, sometimes to make the taste and aroma more intense, coffee and tea are immediately put into a heating pan and heated until the water boils.
6	According to you, which has a strong aroma between iced tea or hot tea?	In my opinion, the tea water is hot, because there is smoke coming out of the brewing tea

The results of the interview are as presented in Table 1, then verification and reduction, conceptualization and scientific reconstruction were carried out by comparing with the Ngopi culture; the results are presented in Table 2.

Table 2. Scientific Reconstruction of Indigenous knowledge of the Community Regarding Ngeteh and Coffee Culture, its benefits and aroma

Question Focus	Indigenous Knowledge of the Community	Scientific Knowledge
Indigenous knowledge of the community regarding tea and tea culture	The Ngeteh culture and drinking tea is the cultural wisdom of Indonesian society. Tea is a local Indonesian wisdom plant. The interviewee stated that the	The tea plant is a plant that has another name, namely <i>Camellia sinensis</i> . [20]
Why do you like coffee drinks over Ngeteh?	aroma of coffee is better than tea, and after drinking coffee it can make the body fresher and not easily sleepy	The caffeine compound contained in coffee can make the mind calmer and less sleepy [21].
Does the interviewee like to inhale the aroma of tea when drinking tea or Ngeteh?	The interviewee said, because the aroma of tea can calm the mind when inhaled and the taste is delicious	The content of caffeine and tannin compounds in tea is useful for increasing a person's focus and concentration of mind [21].
Why does it feel like there is an aroma from tea or coffee, if we drink tea or coffee?	The interviewee said this was because of the water vapor that comes out of coffee and tea when brewed with hot water	In coffee or tea drinking cultures, there are volatile compounds that are easily evaporated, giving a distinctive aroma to the smell of coffee or tea when brewed or drunk hot. Caffeine in tea and coffee has a calming effect when inhaled and can increase focus and concentration of thinking, so that when you drink coffee or tea, your body is fresh, energetic and enthusiastic about working.
What do you feel when you smell tea or coffee?	The interviewee stated that when you inhale the aroma of coffee it is fresher, while tea makes you calmer	
Which aroma of tea or coffee has a stronger aroma, if it is a tea bag or a single use coffee with two uses?	The interviewee stated that the aroma was sharper after using it once	Concentrate on tea bags that have been used once more than those that have been used many times

In this research, data was also examined regarding the responses of UNNES chemistry education students regarding the culture of ngeteh or drinking tea as a form of local wisdom. Questions submitted by students related to (a) Ngeteh culture, (b) tea making process, (c) tea aroma, (d) health benefits of tea, (e) diversity of herbal teas, and (f) preservation of herbal tea culture, as well as (g) student responses to Ethno-STEM IBPjLM. In this study, 88 students were given a questionnaire, then four answers were prepared for each question with a score of 1 disagree, score 2 disagree, score 3 agree, while score 4 strongly agree.

The results of each student's answers are added up, divided then by the number of students, to obtain an average score, the calculation results of which are presented in Table 3. In this research, if the average score is more than 3.50, it is included high (strongly agree), the average score is between 3.00 – 3.49 in the high category, while below 3 is in the quite high category.

Table 3. Student responses to tea culture, tea aroma, benefits, preserving tea culture, as well as reconstruction and implementation of Ethno-STEM IBPjLM

No	Focus Questions on the Questionnaire	Average Score	Achievement level
1	Students agree that ngeteh culture is an Indonesian and global culture	3,42	Strongly agree
2	Students agree that the original Ngeteh culture without aromatic spices, sweeteners and other fragrances is better.	3,27	High
3	Students agree and believe that tea contains aroma compounds that cure disease and help with fitness.	3,15	High
4	Students agree that the aroma of various teas can be identified by their compound components.	2,94	High quite
5	Students agree that each tea contains different and unique aroma compounds, as local wisdom	3,20	High
6	Students want to preserve the ngeteh culture as local and global wisdom.	3,18	High
7	Students agree that the topic of tea, drinking tea and the aroma of tea can be an interesting topic in Ethno-STEM IBPjLM	3,35	Strongly agree
8	Students agree and respect the community's opinion that ngeteh culture means preserving the nation's culture.	3.37	Strongly agree
9	Students are less interested in learning related to tea culture and IBPjLM Ethno-STEM	2.37	High quite

Table 3 shows that student responses are still very high and high, agree or strongly agree, and understand ngeteh culture, the benefits of drinking tea, making tea, Ngeteh culture is preserved, and Ethno-STEM IBPjLM is suitable for learning related to the topic of tea aroma herbs.

3.2 Reconstruction design of Ethno-STEM IBPjLM Topic Herbal Tea Aroma

The Integrated Model between Ethno-STEM and the Inquiry-Based Project learning model on the topic of herbal tea aroma is presented in **Figure 1**.

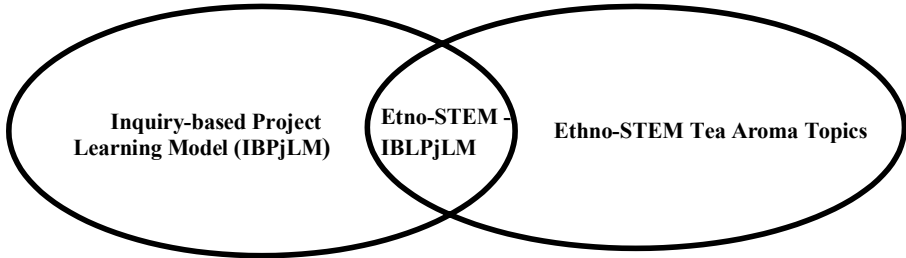


Fig 1. Integration pattern between Ethno-STEM and IBPjLM topic of Tea Aroma.

In this research, an analysis was carried out for the content and scientific components of the Ethno-STEM of the topic Aroma of Indonesian Herbal Tea, the results of which are presented in Table 4.

Table 4. Analysis results for ethnosience and scientific content in the IBPjLM Ethno-STEM topic of Indonesian herbal tea aroma compounds.

Science and Ethnosience	Technology and Ethnotechnology
Science: Herbal tea is scientifically proven to contain secondary metabolites as volatile compounds that have a distinctive smell or aroma. Herbal tea acts as a body immunity, antioxidant and anticancer agent, as well as various herbal teas. Sains: Ethnosience Indigenous knowledge from the community about local plants that can be brewed to make tea, community knowledge about the benefits of tea, the aroma of herbal tea, and the culture of drinking tea.	Technology 1) skilled in using herbal tea making tools and herbal tea volatile compound extractors, as well as laboratory equipment. 2) skilled at using a computer to search for information data related to herbal teas, chemical components, and relevant articles Ethnotechnology Understand the technology of making traditional herbal tea by boiling, brewing and filtering
Engineering and Ethnotechnology	Mathematics dan Ethnomathematics
Engineering Engineering to produce the best tea drinks that are beneficial for health, engineering an Arduino gas tracer device to identify volatile compounds from local herbal tea. Ethnoengineering Indigenous knowledge from the community about how herbal tea is more efficacious, long-lasting and delicious; and delicious.	Mathematics Calculating types and composition of herbal volatile tea Ethnomathematics Mathematical literacy is traditionally related to making herbal teas for drinking .

In this research, the learning was carried out in four meetings with UNNES Science education students for Ethnoscience and Local Wisdom courses. The topics discussed in this lecture are (a) tea culture and global local wisdom, (b) reconstruction of the Ethno-STEM IBPjLM design topic of herbal tea aroma, (c) the inquiry learning process is discussed regarding the trapping and identification of volatile compounds in herbal tea, and (e) explained about secondary metabolites, herbal tea and its varieties, isolation techniques, identification of secondary metabolites, and (f) students practiced by inquiry identifying volatile tea aroma compounds with the Arduino gas sensor. In its integration into Ethno-STEM, and IBPjLM, students discussed to study in depth the community's knowledge regarding Ngeteh culture, conservation of local wisdom, making herbal tea extracts local plants, as well as the benefits of tea for life.

3.3 Results of Analysis of Aroma Compound of Local Herbal Tea

This research has also carried out analysis of the composition of herbal tea aroma volatile compounds from tropical forest plants using trapping equipment and identification of tea aroma volatile compounds designed by Sudarmin et al [16, 25]. In this research, four tropical forest herbal teas were analyzed for their volatile compound components, namely Bajakah tea, Sumatrana Taxus tea, and Ant's nest tea, where the aroma volatile components include H_2 , CO , CO_2 , alcohol, acetone, LPG and varying ppm content, as shown in Figure 2.

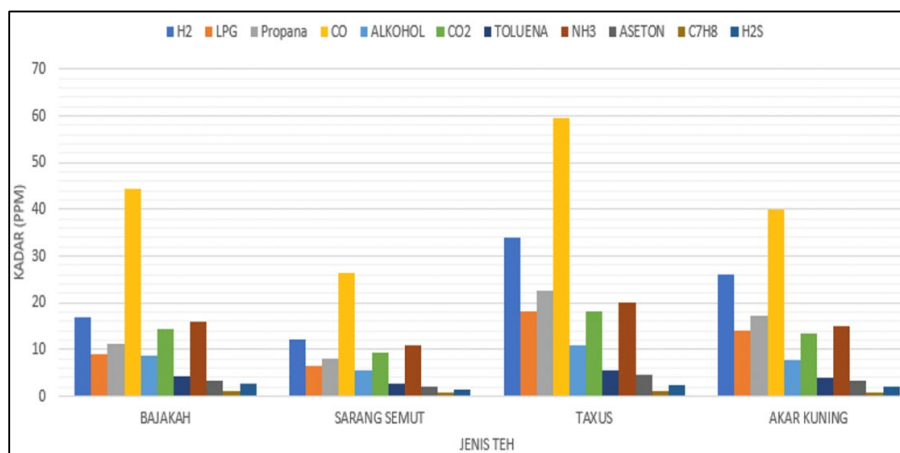


Fig 2. Identification results of herbal tea aroma volatile compounds detected with Arduino gas sensors type MQ2, MQ135, and TGS 2602

In the IBPJLM Ethno-STEM learning about the aroma of herbal tea, the inquiry model applied is from Wenning (25) which includes observation, discovery, interactive demonstrative, lesson inquiry, and laboratory inquiry activities for trapping and identifying volatile compounds in the aroma of herbal tea with an Arduono sensor.

3.4 Response to the Application of Ethno-STEM IBPJLM Herbal Tea Aroma.

In this section, data from the analysis of student responses regarding understanding of tea and tea culture, tea making, the benefits of tea, the aroma of tea, and the application of Ethno-STEM IBPJLM are presented. Data was collected through questionnaires, then student responses were analyzed. As for the application of Ethno-STEM IBPJLM, the topic of tea aroma is carried out in the Mini Research course for UNNES Chemistry Education students. Student responses (a) strongly agree that Ngeteh culture is global local wisdom, (b) are able to understand what tea and Ngeteh culture are, (c) are able to understand the benefits of drinking tea and its manufacture, (d) strongly agree that Ngeteh culture is preserved, and (e) the application of Ethno-STEM IBPJLM, the topic of herbal tea aroma is very interesting.

4 Conclusion

Based on the results of the research and discussion, it was concluded that (1) a scientific reconstruction of Ngeteh culture had been carried out and scientific concepts of Ngeteh culture were found, namely the concept or knowledge of global local wisdom, maceration, extraction and bioactivity of tea aroma compounds, (2) a reconstruction pattern was found between Ethno-STEM and IBPJLM namely the Integrated Model, and (3) volatile compounds from tea have been identified, namely CO, CO, and NH₃, ethanol, and LPG which are trapped by the Arduino gas sensor, (4) students responded well to the design and application of the developed IBPJLM Ethno-STEM.

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