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Exploration of socio-scientific issuess through coffee brewing methods to explore physics literacy: place based educayion at SK Coffee Lab Kediri

***S Aviandari [1], N Suprapto[1], B Arymbekov[2]**
[1]Department of Physics, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya, Surabaya 60231, Indonesia
[2]Al-Farabi Kazakh National University, Kazakhstan

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ABSTRACT

The taste of coffee is not only influenced by the type of coffee but also by the brewing methods. The phenomenon of brewing coffee is an interesting scientific phenomenon that can be used as a Socio-scientific Issues (SSI) theme. SSI are social issues that exist in society, contain the basis of science, and in their resolution trigger dialogue, discussion and debate. The purpose of this study is to determine the level of science literacy as an impact of SSI exploration on the phenomenon of coffee brewing methods. This research uses qualitative methods and is conducted at SK Coffee Lab Kediri with baristas as the source of information. Interviews are arranged based on indicators of science literacy with four main components, knowledge of science, the investigation nature of science, science as a way of thinking, and the interaction of science, technology, and society. Based on this research, the results were obtained that baristas at SK Coffee Lab have a sufficient level of physics science literacy with a percentage of 70%. While the descriptions of each indicator are as follows: the indicator of knowledge of science scored 75% with good criteria, the indicator of the investigation nature of science scored 75% with good criteria, on the indicator of science as a way of thinking scored 80% with good criteria and on indicators of the interaction of science, technology and society scored 80% with good criteria.

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INTRODUCTION

Coffee has become a favorite drink of Indonesians and generally being complementary when reading or doing various other activities. The taste of coffee is not only influenced by the type of coffee but also by the coffee brewing methods. According to the Big Indonesian Dictionary (KBBI), brewing means watering or mixing something with hot water. In the terminology, brewing coffee means watering or mixing coffee with hot water. Brewing coffee is done to extract the substances contained in the coffee so that it can be enjoyed. However, the same coffee if brewed with different techniques can produce different flavors. Some things that need to be considered when brewing coffee are the ratio of coffee and water, the size of coffee particles, the temperature of the water, brewing time, stirring, and maintaining the temperature. This is based on Zarwinda & Sartika (2018) which mentioned that the extraction conditions are solvent, temperature, time, pH, and the ratio of solvency to the material can affect the efficiency of caffeine extraction. Caffeine is one of the bioactive compounds contained in coffee. Caffeine has benefits

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such as stimulating the central nervous system, relaxation of the smooth muscles of the bronchi and stimulating the heart muscle (Zarwinda & Sartika, 2018). Excessive caffeine consumption can cause nervousness, restlessness, tremors, insomnia, hypertension, nausea, and seizures (Zarwinda & Sartika 2018).

Controlling the method of brewing coffee is the same as controlling the extraction rate. This is important because not all compounds contained in coffee are extracted at the same speed or same point. Brewing coffee is not just mixing water with coffee grounds but also involves aspects of science at every stage. Science is a systematic effort to create, build and organize knowledge to understand the universe (GLN, 2017). A person who can use the concept of science in everyday life and can describe and explain scientific phenomena based on scientific evidence is called someone literate in science. Science literacy can also be described as a forum for using scientific knowledge, identifying questions to being able to draw conclusions based on facts in understanding the universe as well as making decisions from changes made by mankind (OECD 2006; Putri et al., 2020). Science literacy skills are seen as must also be possessed by all citizens, not just by students. Such as to answer the question of how people have life skills to be able to compete with other nations so that they can win the global competition. A literate citizen is a citizen that can make more fundamental decisions and can recognize that science and technology are the sources of solutions (GLN, 2017).

Citizens who are literate in science mean that these citizens have the knowledge and understanding of the concepts and scientific processes needed to make decisions, can realize and actively participate in discussions and have a sense of care, and can make decisions on issues that occur in society and the world globally. Therefore, measuring and improving people's literacy is an important thing to do. Various breakthroughs and advances in the field of science or science and technology are constantly being improved to bring about major changes and improve the quality of human life. One of the innovations that have become a hot topic of discussion over the past decade is Socio-scientific Issues or SSI. Most research topics in the field of SSI are related to science literacy, argumentation, and global warming (Deta et al, 2021).

Socio-scientific Issues (SSI) are dilemmatic or problematic issues where scientific knowledge and social consciousness are interrelated with each other and present mental conflicts that require decision-making ability to solve them (Sadler, 2004). Topics in SSI are controversial scientific topics that require moral or ethical reasoning throughout the process of rectification. The purpose is that the issue can be interesting to discuss further and more meaningfully (Zeidler, 2009). These dilemmatic issues can be found in society such as the issue of coffee consumption and its impact on health. With this, an overview of the scope of SSI that is relevant to the problem of coffee brewing techniques and their relation to physical science is presented in the table below.

Table 1. Overview of the scope of ssi relevant to the problem of coffee brewing techniques and their relation to physical sciences

SSI Issues Framework	SSI	Scientific Context	System Involved	Science Content & Concept
	Coffee Consumption	Medical benefit	Brewing coffee	Heat and Temperature

Research on SSI has been widely carried out, especially SSI in education. However, there is not much research on SSI that aims to find out or improve citizens' science literacy. Most of the research conducted is to prepare students to become literate societies, such as the research

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conducted by Kim & Lee (2019) with the title "The Effect of Community-Based Socio-scientific Issues Program (SSI-COM) on Promoting Student's Sense of Place and Character as Citizen". The study aimed to measure changes in the sense of place (SOP) of high school students and character development as citizens (CVGCA). The results of their study showed that the value of SOPs and CVGCA increased.

Apart from SSI, there is also a learning framework outside the classroom that links the potential of the local community with the skills of students at school. The learning framework is Place Based Education (PBE). PBE integrated into the school curriculum can be developed based on the school curriculum (Merdeka Curriculum; Indonesian National Curriculum). PBE integration begins with an analysis of potential which can be in the form of natural resources, human resources, geographical, cultural, historical and other regional potentials that are useful in the process of developing student competencies according to their talents and interests (Kemendikbud, 2011). Specific learning strategies or methods are not binding in the delivery of PBE, but learning strategies and methods are adapted to the existing conditions of teaching materials and the environment.

Inside the coffee shop, the barista is the person responsible for mixing and serving coffee-based drinks. The word barista comes from the Italian word meaning "*Bartender*" or *barmaid*. In addition to mixing and serving coffee-based drinks, baristas are also required to know the entire coffee-making process. A barista who has the competence to mix coffee and meet a certain standard is an important factor in the coffee shop business. Based on The Law of the Republic of Indonesia No.13 of 2003 concerning Barista Manpower is a profession that can be taken after conducting official certification, the competence of a barista is described in the regulation by the Ministry of Manpower and Transmigration of the Republic of Indonesia No. 370 of 2013 concerning Indonesian Qualification Framework includes the ability to plan, prepare and work areas, implement, and manage human resources (HR). The planning stage includes managing raw materials and managing equipment. The preparatory stage includes the preparation of the working area to be used. The implementation phase includes handling customers, operating tools, and developing coffee products. The human resource management phase includes following occupational health, safety, and security (K3) procedures and dealing with English-language conflicts. A barista has a major role in the coffee shop business because the barista's job is not only as a maker and presenter of coffee-based beverages but also required to be able to manage raw materials and production equipment and connect with consumers. Therefore, the objectives of this study are: What is the level of physics literacy among citizens at SK Coffee Lab Kediri?

RESEARCH METHOD

This research used a qualitative approach. According to Sugiyono (2016), the qualitative method is a research method based on the philosophy of postpositivism used to examine the condition of natural objects (as opposed to experiments) where the researcher is the key instrument. The research was conducted at the SK Coffee Lab in Kediri City in June 2022. The object of the research study is the level of literacy while the subject of research is the SK Coffee Lab located in Kediri, East Java.

The data acquisition technique in this study uses the technique proposed by Sugiyono (2016) which consists of interviews, observations, documentation, and data triangulation or combined.

Interview

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The interview here was conducted with a Q&A with the SK Coffee Lab barista. The purpose of this interview was to obtain in-depth data or information on science literacy in coffee brewing techniques and for easy analysis, the result of the interview process was quantified. The questions in the interview are based on PISA's science literacy indicators with details as follows:

Table 2: PISA's science literacy indicators

Indicator	Criteria	Score
Knowledge of Science	Presenting the realities, theories, basics, and laws	5
	Presents hypotheses or preliminary estimates, theories, and models	5
	Understand knowledge or information	5
	Presenting/explaining material about accurate physics	5
	Can present related facts and hypotheses	5
The Investigation Nature of Science	Answering questions about practicum activities through the use of materials.	5
	Answering questions through the use of graphs, tables, and so on	5
	Make calculations	5
	Describe procedural steps	5
	Conducting experimental activities or thinking activities	5
Science as a Way to Thinking	Describing how a scientist conducts experiments	5
	Demonstrates inductive and deductive reasoning abilities	5
	Analyzing causal relationships	5
	Presenting facts and evidence	5
	Presenting the scientific method and problem-solving	5
Interaction of Science, Technology, and Society	Describing the use of science and technology for society	5
	Showing concern for the environment due to the application of science and technology	5
	Showing the negative effects of science and technology on society	5
	Discuss social issues related to science or technology	5
	Mention of careers and jobs in science and technology	5

After getting a score from each category and summing it up, the percentage method will be used. Percentage of criteria for categories of science literacy indicators:

$$Score\ (\%) = \frac{\Sigma\ Total\ Score\ Obtained}{\Sigma\ Maximum\ Score} \times 100\% \quad .....(1)$$

Table 3: Percentage of criteria for categories of science literacy indicators (Source: Depdiknas, 2006)

Score (%)	Criteria
0 – 49,99	Bad
50,00 – 74,99	Sufficient
75,00 – 87,49	Good
87,50 - 100	Very Good

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Observation

According to Sugiyono (2016) observation is a data processing technique that has specific characteristics when compared to other techniques. In this case, observation is carried out by observing directly the process of brewing coffee using the V60 tool.

Documentation

The documentation carried out in this study was to take Figureures in the form of photos, and record the results of interviews with informants related to video and audio.

Triangulation

In this study, researchers used one type of triangulation, which is method triangulation. Data is considered valid if the results of interviews and observations have the same conclusion.

RESULTS AND DISCUSSION

Based on the analysis and processing of data on the level of physical science literacy at SK Coffee Lab, the following results are obtained.

Table 4. Category analysis of science literacy indicators barista sk coffee lab

No	Indicator	Score	Percentage	Description
1	Knowledge of Science	15	75%	Good
2	Investigating the Natural of Science	15	75%	Good
3	Science as a Way of Thinking	20	80%	Good
4	Interaction of Science, Technology, and Society	20	80%	Good
	Total	70	70%	Sufficient

Based on this research, the results were obtained that baristas at SK Coffee Lab have a sufficient level of physics science literacy with a percentage of 70%. The descriptions of each indicator are as follows on the indicator knowledge of science scored 75% with good criteria, in the indicator of the investigation nature of science scored 75% with good criteria, on the indicator of science as a way of thinking scored 80% with good criteria and on indicators of the interaction of science, technology, and society scored 80% with good criteria. This shows that although the overall results of physical science literacy of the SK Coffee Lab barista got sufficient criteria, the details of each indicator showed good results.

The meaning of the score on the first indicator of science knowledge is that the score of 75% indicates that the barista can properly present the realities, theories, basics, and laws; understand knowledge or information, and: present related facts and hypotheses. This is evidenced when brewing coffee, filter paper, servers, and containers used to serve the extraction results are rinsed using the same water used for brewing. The reason is that in addition to cleaning from coffee residues that may be left behind, it is also to keep the extraction temperature stable and there are no significant temperature changes that can later damage the extraction results. It is corresponding with Joseph Black's Principle:

"In mixing two substances, the amount of heat released by a higher temperature substance is the same as the amount of heat received by a substance with a lower temperature"

$$Q_{release} = Q_{received} \text{.....(2)}$$

$$m_1 c_1 (T_1 - T_c) = m_2 c_2 (T_c - T_2) \text{.....(3)}$$

With details:

m_1 = Mass of object 1 (Kg)

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m_2 = Mass of object 2 (Kg)
T_1 = Temperature object 1 (°C)
T_2 = Temperature object 2 (°C)
T_c = Mixed Temperature (°C)
c_1 = Heat type 1 (J/Kg °C)
c_1 = Heat type (J/Kg°C)



Figure 1. Rinsing filter paper using water used for brewing



Figure 2. Rinsing serving container using water used for brewing

In the second indicator, namely the investigation of the nature of science, the meaning of the score of 75%, namely baristas can well answer questions related to practical activities through the use of material (material in their fields); describe procedural steps, and; conduct experimentally activities or thinking activities. The activity of brewing coffee in a coffee shop is one of the activities that involve procedural stages. Starting from the preparation of tools and materials, including calibration of thermometers and digital balance sheets, then brewing activities are carried out in stages. The preparatory stage begins with weighing the necessary coffee beans, the coffee beans are then ground according to the desired degree of roughness. After that, sterilize the tool to be used using the same water that will be used for brewing. The brewing stage begins with putting coffee grounds into a brewing device and brewing with water that is twice the mass of the coffee mass. Waited for 30 seconds then the next brewing until the full volume of water or the volume of the serving.

In the third indicator, namely science as a way of thinking the meaning of the 80% score, namely baristas can act as a scientist conducts experiments; analyze causal relationships; present facts and evidence of science; and present the scientific method and problem-solving. The purpose of brewing coffee is to extract the substances contained in the coffee beans. In general, SK Coffee Lab uses two types of coffee, namely robusta and arabica coffee. Each type of coffee has its characteristics. Robusta coffee has a bitter and strong taste while Arabica coffee has a more aromatic taste. This type of arabica coffee is often created using various kinds of coffee brewing tools such as V60. On arabica coffee wrappers, usually, the main aroma of the beans is listed according to the area of cultivation and treatment at the time of planting to frying and roasting. So, when there is a new arabica coffee coming in the coffee shop, the barista will try various tools with temperature variations, the degree of fineness in grinding, the extraction time, and dosage to test whether the taste and aroma match what is indicated on the label or not. If you have found it, it will be created with other additional ingredients to create a new recipe to be included in the

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menu book. This kind of attitude is like the attitude of a scientist in conducting experiments to test a hypothesis.



Figure 3. The barista showed one example of the newly arrived arabica coffee. Originally from the Gayo-Aceh cultivation area.

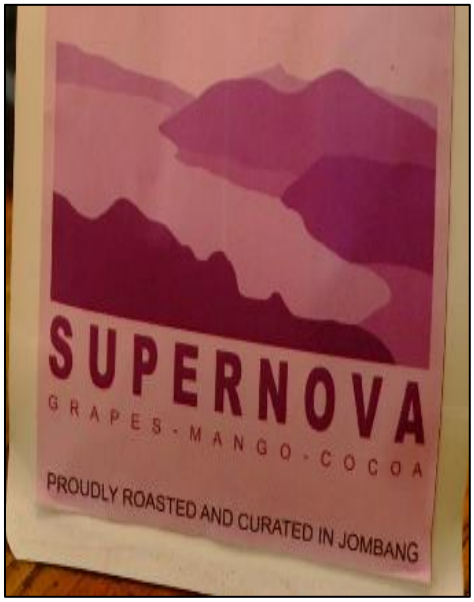


Figure 4. Description of the coffee wrapper that lists the aromatic coffee, grinding, and packaging area.

In the criteria of presenting facts and scientific evidence, the barista mentioned in his interview that one of the reasons for the lack of maximum effect contained in coffee is an error in the timing of consumption. In the excerpt of the interview results as follows:

"*There are certain times to consume coffee. The best is 2 hours after waking up. If you wake up directly consuming coffee, it will have bad consequences on your health. The right time to consume coffee is 9 am, 1 pm, and 3 pm. One of the bad consequences of consuming coffee at night is that the body should rest becomes work due to the influence of caffeine which can stimulate adrenal hormones.*"

In fact, according to health, the body has adrenal hormones. This hormone is produced in the adrenal glands and serves to improve focus and alertness. The highest levels of the hormone cortisol reach a peak at 8 to 9 a.m. and will decline further afterward. When the hormone cortisol decreases, that's when the body needs the caffeine present in coffee.

In the fourth indicator, namely the interaction between science, the technological environment, and society, the meaning of the score of 80%, namely baristas can describe the usefulness of science and technology for society; show concern for the environment due to the application of science and technology; demonstrate the negative effects of science and technology on society and discuss social issues related to science or technology. The usefulness of science and technology can be found in equipment in the world of coffee brewing that uses special tools with a specific purpose. Like a gooseneck kettle equipped with a thermometer so that the temperature in the kettle can be well controlled. A barista must also have good communication skills.

Discussion

Proficient Standart of Science Literacy

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A proficient standard is a point on a proficiency scale that represents a 'challenging but reasonable' expectation of student achievement at a particular year level.

Table 5. Proficient standart of science literacy

Level	Descriptor
6	"Level 6 students **consistently demonstrate** advanced scientific thinking and reasoning requiring the use of models and abstract ideas and use such reasoning in unfamiliar and complex situations. They can develop arguments to critique and evaluate explanations, models, interpretations of data, and proposed experimental designs in a range of personal, local, and global contexts."
5	"Level 5 students **show evidence** of advanced scientific thinking and reasoning requiring the use of models and abstract ideas and use such reasoning in unfamiliar and complex situations. They can develop arguments to critique and evaluate explanations, models, interpretations of data, and proposed experimental designs in some but not all personal, local, and global contexts."
4	"Level 4 students show evidence of linked scientific thinking and reasoning and **can apply** this to unfamiliar situations. Students can also develop simple arguments to question and critically analyze explanations, models, interpretations of data, and proposed experimental designs in some personal, local and global contexts."
3	"Level 3 students show some evidence of linked scientific thinking and reasoning, usually applied to familiar situations. Students can develop partial arguments to question and critically analyze explanations, models, interpretations of data, and proposed experimental designs in some personal, local and global contexts."
2	"They can transform and describe simple data, identify straightforward errors, and make some valid comments on the trustworthiness of scientific claims. "
1a	Have basic knowledge of Science, can explain and apply them to a familiar situation.
1b	Have basic knowledge of Science and can apply them to a familiar situation

(OECD, 2015 with changes)

SK Coffee Lab's barista science literacy level is at level 3. The reason why the barista rinses the filter paper and the container used for extraction using the same water used for brewing is one the proofs that the barista can use his scientific thinking and reasoning to solve common problems that he encounters. In addition, baristas can design experimental steps to test the aroma of coffee.

Connection Between PBE and SSI

Place-based education is an environmentally and culturally conscious learning approach to education that uses the local environment as a context for learning. PBE as learning that is carried out outside the classroom is oriented towards developing students' skills that corresponding with the potential for local excellence, so it can be ensured that this learning is carried out through a student-centered constructivism approach. The existence of the teacher as a facilitator in PBE can dilute the formal and rigid atmosphere that often occurs in conventional learning. Teachers must be able to design learning programs to help develop skills such as critical thinking, problem solving skills, and strategies for social change.

While epistemologically, SSI-based learning can be called a model because it has a theoretical framework of application that can be practically spelled out in its implementation. Marks & Elks (2009) in their research developed a variety of SSI-based science learning strategies, one of which is The Socio-critical Issues and Problem Oriented Approach. This variety conceptually has four elements, namely: learning objectives, issue selection criteria, learning methods, and learning plan structure. With this, an overview of the scope of SSI that is relevant to the problem of coffee brewing techniques and their relation to physical sciences according to Marks and Elks can be seen in the table below.

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Table 3. Overview of SSI Scope According to Marks and Elks

SSI Issues Framework	Purpose	Issue Selection Criteria	Method	Lesson Plan Structure
	Science Literacy	Relevant	Laboratory Work	Classification of scientific aspects through investigation

Based on table 3, it can be described that the purpose of using the SSI learning framework is to achieve scientific literacy. By selecting relevant issues, namely brewing coffee which contains physics principles. It was carried out using the laboratory work method, which was realized by practicing brewing coffee in the barista's kitchen with the type of coffee and the ratio of coffee grounds and water as the control variables, temperature and extraction time as manipulative variables, and the taste of the extraction results as independent variables. The structure of the lesson plan is carried out by classifying scientific aspects through investigation.

SSI and PBE-based learning can be combined so that they have learning objectives that can complement each other. The general description of the relationship between PBE and SSI can be seen in the image below.

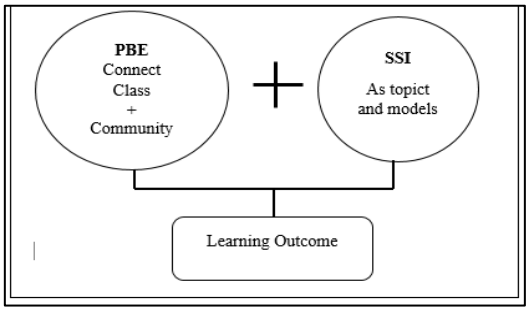


Figure 5. The relationship between PBE and SSI

In the case of this study, the local community that was used as a source of learning was the coffee community at the SK Coffee Lab. In practice in the field, a coffee shop is not only a place to enjoy coffee, but it is also a community consisting of SK employees and customers. As for the class here, what is meant is the student class at school. The issue of SSI brewing coffee is included in the chapter on Temperature and Heat because it contains one of the principles in physics, namely the Joseph Black principle. In physics subjects at schools, especially at the high school level, the subject of temperature and heat is given in class XI at Basic Competency (BC) 3.5 and 4.5 with the following description:

BC 3.5 Analyzes the effect of heat and heat transfer which includes the thermal characteristics of a material, capacity and heat conductivity in everyday life.

BC 4.5 Design and conduct experiments on the thermal characteristics of a material, especially with regard to capacity and heat conductivity, along with the presentation of the experimental results and their utilization.

The combination of PBE and SSI produces learning outcomes in the form of increased science literacy in students. This is still relevant to the research of Deta et al (2021) which states that one of the most frequent topics in SSI research is scientific literacy.

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CONCLUSION

Based on this research, the results were obtained that baristas at SK Coffee Lab have a sufficient level of physics science literacy with a percentage of 70%. The descriptions of each indicator are as follows on the indicator knowledge of science scored 75% with good criteria, in the indicator of the investigation nature of science scored 75% with good criteria, on the indicator of science as a way of thinking scored 80% with good criteria and on indicators of the interaction of science, technology, and society scored 80% with good criteria. This shows that although the overall results of physical science literacy of the SK Coffee Lab barista got sufficient criteria, the details of each indicator showed good results. SK Coffee Lab's barista science literacy level is at level 3 it proofs that the barista can use his scientific thinking and reasoning to solve common problems that he encounters. In addition, baristas can design experimental steps to test the aroma of coffee.

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Author (s):

* Silvi Aviandari (Corresponding Author)
Department of Physics, Faculty of Mathematics and Natural Science,
Universitas Negeri Surabaya,
Jl. Ketintang, Surabaya 60231, Indonesia
Email: silvi.17030184091@mhs.unesa.ac.id

Nadi Suprapto
Department of Physics, Faculty of Mathematics and Natural Science,
Universitas Negeri Surabaya,
Jl. Ketintang, Surabaya 60231, Indonesia
Email: nadisuprapto@unesa.ac.id

Beken Arymbekov
Al-Farabi Kazakh National University, Kazakhstan
Email: B.Arymbekov@satbayev.university