Stem Education and Research-Based Learning Activities on Taste Roasted in Coffee

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ABSTRACT. Society Era 5.0 is a society that can solve various challenges and social problems by utilizing various innovations from the Industrial Revolution Era 4.0. To be able to face the society era 5.0, students have to be equipped with 21st century skills and basic literacy skills (data literacy, technological literacy, human beings). Thus, appropriate learning approach is needed, i.e., the application of the STEM approach and the Research Based Learning (RBL) model. STEM is an approach that combines four fields, Science, Technology, Engineering, and Mathematics. The RBL model trains students to be able to solve problems that occur in the surrounding environment and are appointed as research. Today's modern society is very fond of drinking coffee, and Indonesia is one of the largest coffee-producing countries in the world. Coffee contains a lot of secondary metabolites that are very beneficial for health, antioxidants. One of the processes in serving coffee is through the roasting process, but this process can damage the secondary metabolite content. With the application of STEM and RBL, students will conduct research or simple research, assessing the right roast level for several types of coffee so that they can produce coffee that has the right taste. The purpose of this study was to design learning based on the STEM approach and related RBL models by assessing the right roast level for several types of coffee so that they could produce the right taste.

Keywords: STEM · RBL · Roasted coffee

1 Introduction

The journey of education in Indonesia does not escape the influence of changing times which causes a shift in educational goals national. Globalization that has hit the whole world in the 21st century has caused the goal of national education to no longer only educate the nation and liberate humans, but shifts towards education as a commodity because it emphasizes the mastery of Science, Technology, and Arts (IPTEKS) which are pragmatic and materialist. This is certainly a concern for all of us considering that the purpose of National Education as stated in Law No. 20 of 2003, Article 3, is not only oriented towards pragmatism and materialism but has a complete goal to form humans who have faith and piety (IMTAQ) and master science and technology. The shift in the

goals of national education is increasingly felt today with the occurrence of a character crisis in the field of education, because pragmatism in responding to the needs of the labor market places more emphasis on materialistic matters so as to forget teaching with the spirit of nationality, social justice, and human traits that have noble morals as citizens [1].

The Process Standards contained in SN-Dikti are the basis for the Independent Learning Campus policy in Higher Education which is implied in the Graduate Learning Outcomes (CPL) in Study Programs. Students have the opportunity to gain learning experiences outside of their study program and are oriented to acquire 21st century skills that foster 6C HOTS (high order thinking skills) needed in the Industrial Revolution 4.0 era, including communication, collaboration, critical thinking, creative thinking, computational logic, compasion., and civic responsibility [1].

In addition to the demands of MBKM, student teacher candidates who are in LPTKs have few obstacles and obstacles in the learning process. Some of the obstacles and obstacles faced by prospective Biology teachers are very complex biology materials, some materials require memorization, and the learning process is a bit boring. Related to some of these obstacles, the right solution is needed, namely providing students with abilities that provide cognitive regulatory skills called abilities metacognition that can support problem solving. Metacognitive abilities are high-level cognitive abilities needed for knowledge management where students are required to set their own learning goals and can determine appropriate learning strategies to achieve these goals. The responsibility of students also includes monitoring the learning process and changing learning strategies when necessary [2].

Achieving this requires proper learning as a foundation for student provision. To achieve these demands, appropriate learning tools are needed which contain appropriate learning strategies, so that learning can run optimally and CPL can be achieved. An educator is required to be able to prepare interactive learning, student center, utilize the potential around him as well as the application of concepts in several fields as a provision to face the world of work. The effort is to develop learning tools with an RBL model based on the STEM approach.

Analysis of the potential of Arabica coffee with the roasting process is closely related to how the roaster works, so that coffee products can be produced that are safe for consumption but can also provide many benefits for coffee connoisseurs. Coffee contains a lot of secondary metabolites, which will be maximized if the roasting process can be adjusted in such a way. In understanding how roasting equipment works, students' abilities are needed, namely technological literacy. Technological literacy on how roasters work, especially in setting temperature and time. An appropriate learning strategy is needed to support learning, so that students' abilities can be achieved. STEM is a meta-discipline at the school level where science, technology, engineering, and mathematics teachers teach an integrated approach and each discipline material is not divided but handled and treated as a dynamic whole [3]. One of the learning approaches that can accommodate the characteristics of 21st century learning and some of the 21st century skills is the approach Science, Technology, Engineering, and Mathematics (STEM). States that integrated STEM education is an approach to teaching two or more STEM

Fig. 1. Roaster Machine

Fig. 2. Coffee Roasting

fields by involving STEM practices in connecting each STEM field in order to improve student learning [4] (Figs. 1 and 2).

STEM has been implemented in a number of developed countries such as the United States, Japan, Finland, Australia and Singapore. STEM is an initiative of the National Science Foundation. The purpose of implementing STEM in the United States is to make these four fields (science, technology, engineering, and mathematics) the main career choices for students [5, 6]. STEM has been widely applied in learning. This situation is shown from the results of research which reveal that the application of STEM can improve student achievement and non-academic. The application of STEM is also able to increase the mastery of knowledge to solve problems, as well as encourage students to innovate or create new products [7, 8].

In learning, there are many things that must be considered, in addition to being related to the learning approach, the selection of learning models is also very important. A teacher also acts as an inspiring character for his students. By creating interesting learning by presenting very dynamic and ICT-based interactions. Lecturers should not tell the history related to science, but have a contribution in related fields through presenting the results of research carried out, so that learning becomes very interactive. One model that supports this is Research Based Learning (RBL). The RBL model is a learning model that supports research. The RBL model can also improve and build students'
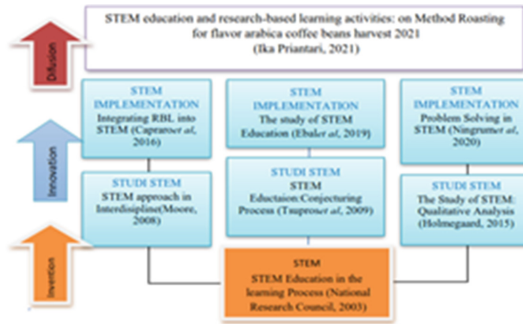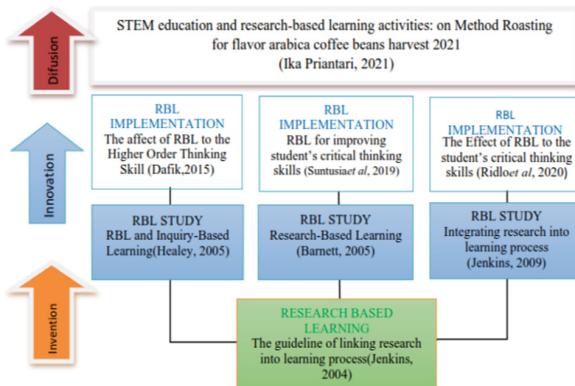
Fig. 3. State of the art STEM

Fig. 4. State of the art RBL

thinking skills by connecting theory and practice [9]. By applying the STEM approach and the RBL model, it is hoped that students can improve their cognitive abilities, because they are accustomed to doing research through the RBL model and linking research conducted with STEM. Students are accustomed to being required to learn independently, by determining their own learning strategies and being able to achieve the learning objectives that have been set. So that students have good metacognition in solving problems (Figs. 3 and 4).

The research presented is STEM-based, with a Science component related to the metabolite content of Arabica coffee in different varieties with graded roasting techniques so that coffee has extraordinary benefits, the Technology component by using roasting temperature and maturity levels can be adjusted to get coffee that has benefits, components Engineering students' understanding of how the roaster works, Mathematical components with the right time calculation to get the right coffee (Fig. 5).
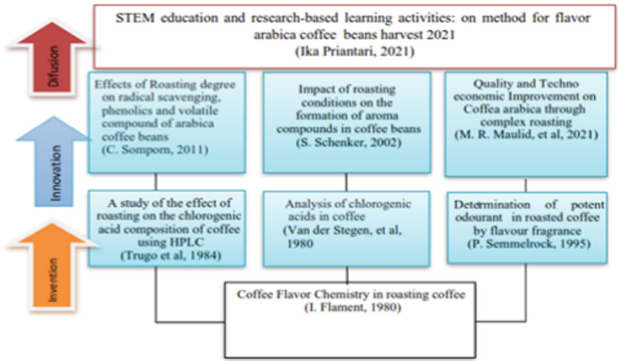
Fig. 5. State of the art Roasted coffee and STEM dan RBL

2 Methods

This study uses a qualitative research approach. Qualitative research is a research approach that uncovers certain conditions by properly describing facts, compiled through words based on relevant data collection and analysis techniques, and obtained from actual or natural situations and conditions.

The research method used is a literature study method. Literature study method is research by searching and analyzing data sourced from relevant previous research results. Research with the literature study method is a research in which data collection comes from the library, reading, taking notes, and processing research materials. The data obtained is secondary data. The data is then compiled, analyzed, and then concluded. Literature study is a data collection technique by conducting a study of books, journals, notes, and reports that have to do with the problem to be solved. Literature study is an important step because researchers will collect as much information as possible from relevant literature sources.

Therefore, in this study colaborate a learning activity design using a STEM approach combined research-based learning to solve the problem of using on taste roasted in Coffee, by assessing the right roast level for several types of coffee so that they could produce the right taste. The expected research outputs are: (1). Posing problem on some basic problems roasting coffee for flavor of arabica coffee beans of harvest 2021 (Science), (2) Developing new breakthroughs related to method roasting for flavor arabica coffee of harvest 2021, (3) collect data related to method roasting for flavor of arabica coffee beans through web browsing, and other media channels (Technology), (4) Using method light roast, medium roast, dark roast for flavor of arabica coffee beans harvest 2021 (Mathematics and Technology), (5). Performing SCAA (Speciality coffee Association of America Cupping Form) (Mathematics and Mathematics), (6). Presenting the results of on students research related to roasting method for flavor arabica coffee beans harvest 2021 (RBL Report).
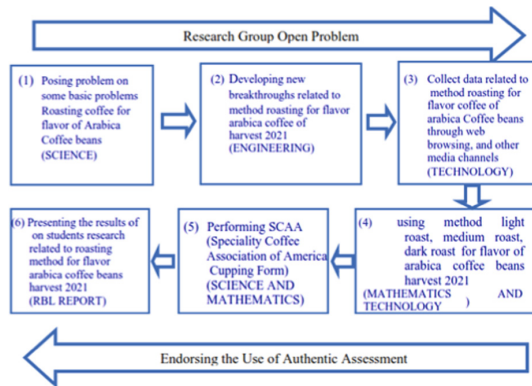
Fig. 6. The Framework Learning Activities RBL and STEM Education

3   Result

Framework learning activities RBL and STEM Education it can improve metacognitive skills in solving problem on roasting method for flavor arabica coffee beans from harvest 2021. Learning outcome student metacognitive skills (1). Students are planning roasting method for flavor arabica coffee beans harvest 2021 (Planning), (2). Students are monitoring for roasting process for flavor arabica coffee beans harvest 2021 (monitoring), (3). Students are checking and reporting best roasting method for flavor arabica coffee beans harvest 2021 (Evaluation).

There are 6 stages for RBL activities and STEM Education on roasting method. Based Fig. 6, the first stage (SCIENCE) is proposing the fundamental problems related to roasting coffee method for flavor.

3.1   RBL and STEM Activities on Identifying the Potential Problem

Lecturers and students in stage 1 enter the STEM section, namely Science, and enter the RBL syntax, namely identifying the potential problem. In this stage, the Lecturer opens a discussion regarding the coffee processing process, upstream and downstream coffee processing. One of the main processes in coffee processing that determines the taste of coffee is the roasting method. Coffee roasting methods based on temperature differences consist of 3 kinds of Light, Medium, Dark. Introducing the varieties of Arabica coffee. For more details can be seen in Table 1.

3.2   RBL and STEM Activities on Identifying the Strategy for Potential Solution

Lecturers and students in stage 2 entered the STEM section, namely Engineering, and entered the RBL syntax, namely Identifying the Strategy for Potential Solutions, and entered the Indicators of metacognitive skills, namely Plan. In this stage, the lecturer instructs students to design a simple research plan (practicum) related to the right coffee roasting method in order to produce the best taste. For more details can be seen in table 2.

Table 1. Learning activities RBL-STEM stage 1

STAGE I	ACTIVITY
Problem Posing arising from open problems (Science)	1. The lecturer will ask about the coffee processing process? 2. The lecturer will ask what factors affect the taste of coffee? 3. Lecturers will ask students if they know about coffee roasting methods? 4. The lecturer will ask how many coffee roasting methods are there? 5. Lecturers will ask What are the varieties of Arabica coffee? 6. Lecturers will ask students which roasting method is right for Arabica coffee from the 2021 harvest?

Table 2. Learning activities RBL-STEM stage 2

STAGE 2	ACTIVITY
Develop a problem solving strategy (Engineering) (Plan)	The lecturer will ask students in groups to design a simple research (practicum) with various varieties of Arabica coffee harvested in 2021 and choose the right method to produce coffee with the best taste. Students discuss with the group designing a simple research (practicum) choosing one Arabica coffee variety and applying the roasting method so that coffee with the best taste can be produced. Students identify appropriate equipment and materials with a simple research (practicum) planned together with the group

3.3   RBL and STEM Activities on the Data Collection for Potential Solution

Lecturers and students in stage 3 are included in the STEM section, namely Technology, and enter the RBL syntax, namely Data Collection, and are included in the indicators of metacognitive skills, namely Controlling. Lecturers monitor students doing roasting Arabica coffee from harvest 2021 practicum by trying several roasting methods (light, medium and dark roast) to find the best taste. After the coffee is roasted with 3 methods (light, method and dark roast) it will be ground into coffee grounds. Ground coffee is brewed with hot water at a temperature of 90 °C, students will perform an organoleptic test using the SCAA form to test and determine the best taste (of the 3 roasting methods used). Students collect and record data from organoleptic test results based on the SCAA (Speciality Coffee Association Arabica) Cupping Form using the Excel program (Table 3).

Table 3. Learning activities RBL-STEM stage 3

STAGE 3	ACTIVITY
Orientation, data collection, tabulating (Technology) (Monitoring)	Students in each group with different varieties conduct roasting Arabica coffee from harvest 2021 practicum by trying several roasting methods (light, medium and dark roast) to find the best taste. Students will grind coffee beans into ground coffee. Ground coffee is brewed with hot water at a temperature of 90 °C, students will perform an organoleptic test using the SCAA form to test and determine the best taste (of the 3 roasting methods used). Students collect data from organoleptic test results based on SCAA (Speciality Coffee Association Arabica) Cupping Form using the Excel program.

Table 4. Learning activities RBL-STEM stage 4

STAGE 4	ACTIVITY
Data analysis, predicting, process, validation (Mathematics and Technology) (Evaluation)	Students in groups analyzed data from organoleptic test results based on SCAA (Speciality Coffee Association Arabica) Cupping Form using the Excel program. Data analysis includes looking at the results of roasting coffee beans and adjusting to Aqtron Roasted Coffee, organoleptic test results are statistically analyzed using Excel or SPSS to see which variety of coffee and the right roasting method so that it can produce the best coffee taste. In addition, look at the comparison between varieties and roasting methods.

3.4 RBL and STEM Activities on the Data Analysis for Potential Solution

Lecturers and students in stage 4 are included in the STEM section, namely Mathematics and Technology, and enter the RBL syntax, namely Data Collection, and are included in the Indicators of metacognitive skills, namely Controlling. Lecturers monitor students to analyze data from organoleptic test results based on SCAA (Speciality Coffee Association Arabica) Cupping Form using the Excel program. Data analysis includes looking at the results of roasting coffee beans and adjusting to Aqtron roasting coffee bean, organoleptic test results are statistically analyzed to see which varieties of coffee and roasting methods can produce the best taste. In addition, look at the comparison between varieties and roasting methods (Table 4).

Table 5. Learning activities RBL-STEM stage 5

STAGE 5	ACTIVITY
Generalizing (Mathematics and Technology) (Evaluation)	The lecturer asks students to process data from the results of data analysis and conduct a literature review so that conclusions can be drawn from each group.

Table 6. Learning activities RBL-STEM stage 6

STAGE 6	ACTIVITY
Presenting RBL Report (Evaluation)	1. Students in each group present the conclusions of a simple research (practicum). 2. Lecturers can analyze data using data from student groups, and it can be concluded that the best varieties and roasting methods to produce the best taste of Arabica coffee from the 2021 harvest and publish.

3.5 RBL Activities on the Generalizing data analysis with literature for potential Solution

Lecturers and students in stage 5 are included in the STEM section, namely Science and Mathematics, and enter the RBL syntax, namely generalizing data, and are included in the Indicators of metacognitive skills, namely Evaluation. The lecturer asks students to process data from the results of data analysis and conduct a literature review so that conclusions can be drawn from each group. For more details can be seen in table 5.

3.6 RBL Activities on Presenting Research Based Learning Report

Furthermore, at stage 6 entered into STEM namely Technology, RBL syntax namely Research Based Learning Report, and entered into Indicators of metacognitive skills namely Evaluation. The lecturer asked each group to present the conclusions from a simple research (practicum). Lecturers can analyze data using data from student groups, and it can be concluded that the best varieties and roasting methods to produce the best taste of Arabica coffee from the 2021 tahin harvest. For more details, see Table 6.

4   Discusion

Coffee processing, consisting of upstream and downstream coffee processing. Upstream coffee processing consists of harvesting, sorting coffee cherries, peeling red fruit skin, fermentation, washing, drying, stripping the epidermis, sorting coffee beans, packaging and storage. After the upstream coffee processing is complete, the downstream coffee processing will continue. Downstream coffee processing consists of roasting, grinding, packaging and brewing. One of the main processes in coffee processing that determines

the taste of coffee is the roasting method. Coffee roasting methods based on temperature differences consist of 3 kinds of Light, Medium, Dark [10]. Introducing the varieties of Arabica coffee. Lecturers monitor students doing roasting Arabica coffee from harvest 2021 practicum by trying several roasting methods (light, medium and dark roast) to find the best taste [11]. After the coffee is roasted with 3 methods (light, method and dark roast) it will be ground into coffee grounds. Ground coffee is brewed with hot water at 90 °C, students will perform an organoleptic test using the SCAA form to test and determine the best taste [12] [13]. Students collect and record data from organoleptic test results based on SCAA (Speciality Coffee Association Arabica) Cupping Form using the Excel program. Students analyze the results of organoleptic tests using the SCAA Cupping Form on Arabica coffee with various roasting methods so that the coffee with the best taste can be determined with the right roasting method.

According to [3] STEM is a meta-discipline at the school level where science, technology, engineering, and mathematics teachers teach an integrated approach and each discipline material is not divided but handled and treated as a dynamic whole. One of the learning approaches that can accommodate the characteristics of 21st century learning and some of the 21st century skills is the approach Science, Technology, Engineering, and Mathematics (STEM). States that integrated STEM education is an approach to teaching two or more STEM fields by involving STEM practices in connecting each STEM field in order to improve student t learning [4]. One model that supports this is Research Based Learning (RBL). The RBL model is a learning model that supports research. The RBL model can also improve and build students' thinking skills by connecting theory and practice [9]. By applying the STEM approach and the RBL model, it is hoped that students can improve their cognitive abilities, because they are accustomed to doing research through the RBL model and linking research conducted with STEM. Students are accustomed to being required to learn independently, by determining their own learning strategies and being able to achieve the learning objectives that have been set. So that students have good metacognition in solving problems.

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5 Conclusion

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