3. On the shrimp chitosan STEM education-pros

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Submission date: 08-Jan-2022 12:29PM (UTC+0700)
Submission ID: 1738767235
File name: 3._On_the_shrimp_chitosan_STEM_education-pros.pdf (1.01M)
Word count: 5806
Character count: 33283

On the shrimp skin chitosan STEM education research-based learning activities: obtaining an alternative natural preservative for processed meat

On the shrimp skin chitosan STEM education research-based learning activities: obtaining an alternative natural preservative for processed meat

R S D Gita[1,3], J Waluyo[1], Dafik[2], Indrawati[1]
[1]Department of Postgraduate of Science Edu., University of Jember, Indonesia
[2]Department of Postgraduate of Math Edu., University of Jember, Indonesia
[3]Department of PAUD, IKIP PGRI Jember, Indonesia

Email: rinagita@ikipjember.ac.id

Abstract. Elaborating Science, Technology, Engineering, and Mathematics in learning activities is now getting important, especially to improve the STEM literacy of the students of school age or higher. For the higher age students, elaborating the STEM education should encourage them to raise their higher-order thinking skills. Thus the implementation of research-based learning together with a STEM education will be a good model in designing learning activities. Meanwhile, in STEM education, integrating some social real-life problems becomes the main issue. In this study, we will focus on the preservation process of food or meat. The biggest problem, in this case, some preservatives, however, contain harmful substances, like formalin and borax. Under STEM education, we will guide students in research-based learning activities to use chitosan made from shrimp skin to be a natural preservative substance. The objective of this study is to design the research-based learning activities under the STEM approach on the use of chitosan preservatives for processed meat.

1. Introduction

One of the competencies that students must have in to face global competition in the 21st century is a creative thinking skill. Creative thinking skills are the ability to put elements together in a coherent and functional unit. Students can be categorized as creative if they can mentally organize elements or parts into new structures that have never existed before and are different from others [1]. Nowadays creativity and innovation are important keywords to ensure sustainable development goals. One of the main ways to build this creativity is by integrating the learning process in the classroom. It is realized that on the shoulders of school students and university students as young future generation, a great nation, like Indonesia, has hopes. They must be prepared to be skilled, flexible and resilient independent learners (agile learner).

Furthermore, the Ministry of Education and Culture of the Republic of Indonesia recently issued a policy related to the "MerdekaBelajar–KampusMerdeka" program. This program is a framework for preparing students to become creative, innovative scholars in the future, so that they can have good transferable skills, ready to become problem solvers in society [10]. Graduates of the undergraduate program must be able to create their jobs, they must not depend on job vacant provided by government. They can take advantage of several non-government sectors, for example agriculture, livestock, plantation, fishery and include creative handicraft businesses, as well as businesses in food products. By combining the use of Internet of Things (IoT) technology and abundant natural resources, they will be able to optimize their transferable skills.

By creative and innovative thinking skills, the younger generation is expected to be able to solve problems that often occur in the environment, such as waste. Waste is possible to be processed into very useful materials. If we leave the waste that has a potential to pollute the environment, will cause problems, for example, the shrimp shell waste. Based on data from the Department of Marine Affairs and Fisheries of Jember Regency, it is known that the amount of shrimp production is

increasing from year to year. The amount of shrimp production in Jember in 2010 was recorded at 16 tons, and in 2011 it was increased to 36.1 tons [5]. The waste that arises from the production of shrimp is shrimp head, shrimp skin, shrimp tail and legs. Those are about 35%-50% of the initial weight. Thus, the shrimp processing industry has the potential to cause environmental pollution around the factory; such as the appearance of unpleasant odors, a slum environment, and the end will be a source of disease [13]. The waste from shrimp processing needs to be handled properly, namely by utilizing the shrimp shell waste into a useful and economical product. The shrimp shell waste can be processed into a product in the form of chitosan. The aim of this research is how to educate students to be able to utilize shrimp shell waste that has been manifested in chitosan as a natural preservative for processed meat through the STEM (Science, Technology, Engineering and Mathematics) learning approach.

Figure 1. A) Shrimp shell waste, B) The chitosan making process, C) The obtained chitosan

Chitosan, see Figure 1c, is an organic compound derived from chitin contained in shrimp shells. Chitosan is non-toxic and easily biodegradable. The presence of amino reactive groups and hydroxyl groups in chitosan is very important as a preservative and color stabilizer. Chitosan can be used as a natural food preservative [8]. Chitosan is able toinhibit the growth of destructive microorganisms, besides that chitosan is also a coating of preserved products or food. Chitosan's specific characteristics such as antibacterial, anti-fungal properties, and its ability to form biodegradable polymers that dissolve easily in water. This makes chitosan an ideal coating material for food products (edible coating).

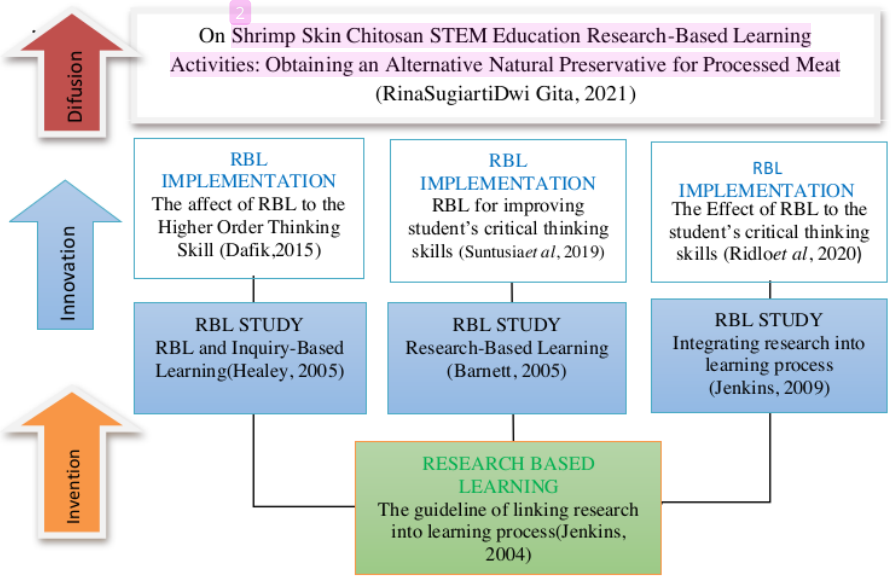

Figure 2. The *state of the art* on RBL model

Furthermore, the Research Based Learning (RBL) learning model has been developed since 2004. In Figure 2, we present the development of the RBL learning model from the beginning till now which the researcher has discovered. Based on Figure 2, we can see that one of the early educational figures that initiated RBL learning was Alan Jenkins [9]. Jenkins provides research guidance including the relationship between learning and research. Furthermore, studies on RBL are continuously carried out by researchers, for example, related to the effectiveness of RBL learning in increasing higher order thinking skills [4], the effectiveness of RBL learning in increasing students' metacognition in solving problems [14], and the effect of RBL towards critical thinking skills [12].

While, the STEM approach is a learning approach that uses science, technology, engineering and mathematics in solving problems of everyday life [15]. STEM is a learning approach that motivates students to emerge mind-on and hand-on-learning through a problem-solving process. Several research results indicate that the STEM approach can develop students' innovative creative thinking skills [2]. Moreover, when the STEM approach is combined with the Research Based Learning (RBL), the learning approach and model will be complete since students are invited to actively develop a new breakthrough in solving existing problems. RBL is a learning model that uses the concept of contextual learning, problem solving, cooperative learning, learning designed to involve students in exploring information or data, authentic learning, and learning models based on invention [4]. Furthermore, the research achievements in the STEM field globally can be presented in Figure 3.

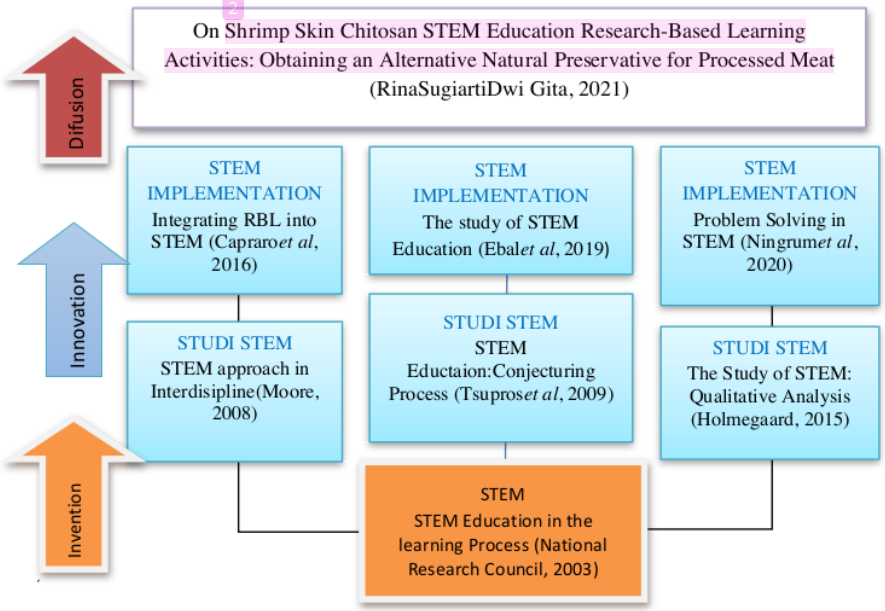

Figure 3. The *state of the art* on STEM education

STEM (Science, Technology, Engineering, and Mathematic) education is widely recognized among academics since 2003 when the NRC (National Research Council) recommended that in STEM learning should motivate several aspects that need to be emphasized, including: (1) asking questions (science) and define the problem (engineering); (2) develop and use models; (3) planning and carrying out investigations; (4) analyzing and interpreting data (mathematics); (5) using mathematics; information technology and computers; and computational thinking; (6) building explanation (science) and designing solutions (engineering); (7) engage in evidence-based argument; (8) obtaining, evaluating, and communicating information.

Furthermore, STEM approach is experiencing various innovations. This is due to the results of research found by several researchers, for example related to the study of STEM approaches across disciplines to encourage learning and student involvement [5]; qualitative study of STEM learning in the university [7]. The next innovation is related to the combination of the implementation of STEM learning with spesific learning models, including the RBL model [3] [11].

Furthermore, related to the problems that will be solved by students in the learning process with the STEM approach is the use of chitosan. Chitosan-related research, we can present it in the chart in Figure 4.

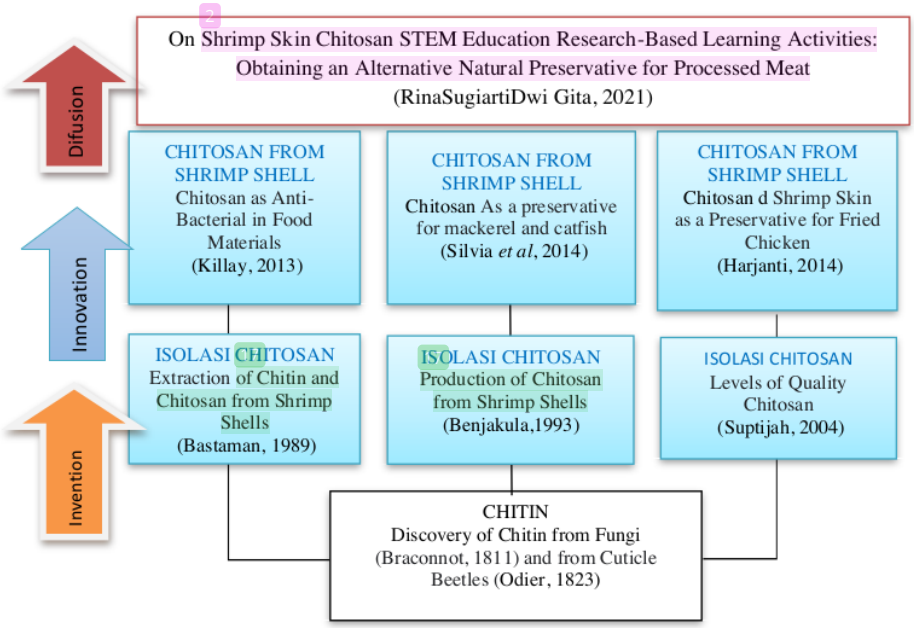

Figure 4. The *state of the art* on chitosan

Chitosan is a compound derived from chitin. Chitosan is obtained by processing chitin through a chemical process, which includes demineralization, deproteination, and deacetylation. Chitin was first discovered from fungi, and then found from beetle cuticles. Along with the development of technology, there are many innovations related to the isolation of chitin and chitosan, for example related to the extraction and degradation of chitin and chitosan from shrimp shells. Production of chitosan from shrimp shells has many benefits since shrimp shell waste is very much found, especially in tropical countries like Indonesia. If we leave the shrimp shells it cause an unpleasant waste and pollution.

The innovations in the implementation of chitosan also continue to develop, for example regarding chitosan as an anti-bacterial in food ingredients.Chitosan becomes a preservative in mackerel and catfish and Chitosan as a preservative for fried chicken. The difference between this study and the previous studies is that chitosan is used as a natural preservative in various types of processed meat, such as meatballs, sausages or nuggets.

Therefore, in this study we will develop STEM learning activities with the RBL model to solve the problem of using chitosan from shrimp skin as a natural preservative for processed meat. Our research title is "On Shrimp Skin Chitosan STEM Education Research-Based Learning Activities: Obtaining an Alternative Natural Preservative for Processed Meat ". In this study, we will integrate the Research Based Learning (RBL) learning model in the STEM approach so that it can improve students' creative thinking skills in solving problems using chitosan as a natural preservative for processed meat.

2. Method

The research uses a qualitative research approach, which is to develop, unravel, or reveal certain conditions or processes by describing facts, concepts, principles, and procedures and are supported by

relevant data. The research method used is the literature study method. Research with the literature study method is a study where data collection comes from literature, reading, taking notes, and processing research materials. A literature study is a data collection technique by analyzing books, journals, notes, and reports related to the problem to be solved.

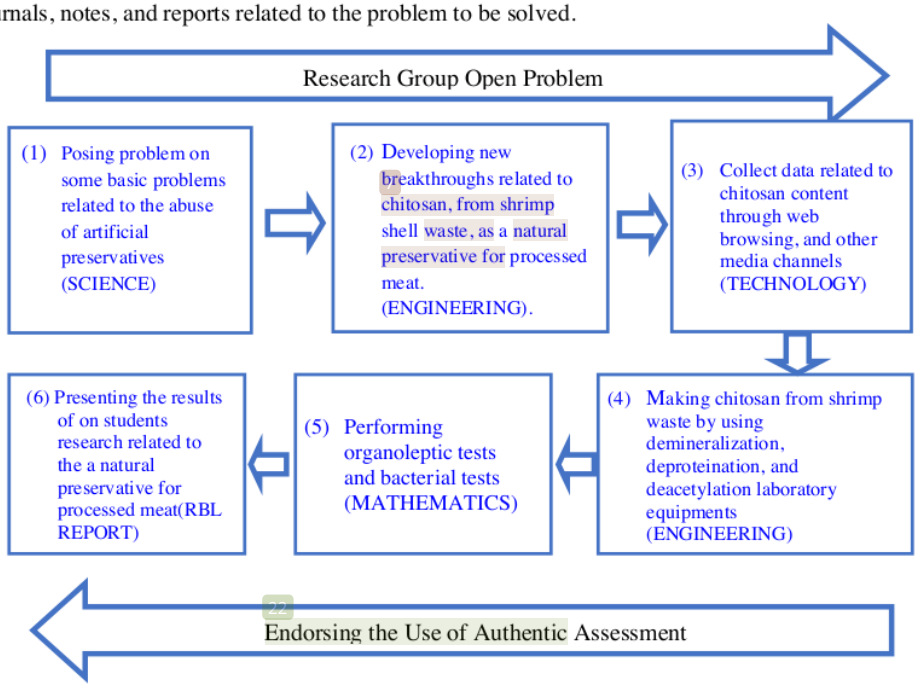

Figure 5. The framework of RBL in STEMeduction

Therefore, in this study, we will try to develop a learning activity design using a STEM approach combined in research-based learning to solve the problem of using chitosan from shrimp shells as an alternative to natural preservatives for processed meat. The expected research outputs are: (1) fundamental problems related to the abuse of artificial preservatives, (2) breakthrough using chitosan (shrimp shell waste) as a natural preservative for processed meat, (3) data related to chitosan content through web browsing, and media channels, (4) chitosan from shrimp waste with laboratory equipment is mineralized, deproteinated, and acetylated, (5) organoleptic test and bacterial test using geometry and comparison, (6) and presentation of research results and observations of students' creative skills, see Figure 5.

3. Result

3.1 *Framework of RBL in STEM*

In the following, we will present a framework for integrating the RBL learning model with the STEM approach such that it can improve students' creative thinking skills in solving problems using chitosan as a natural preservative for processed meat.

3.1.1*Learning Outcome*

Students can demonstrate to make chitosan from shrimp shell waste, analyse the effectiveness of chitosan as a natural preservative in processed meat, test the data, and present their findings orally or in writing creatively, critically and evaluatively, and students are fulfilled with self-confidence and pride on their work.

3.1.2 *Researcher Role*

During the implementation of the RBL learning model together with the STEM approach, students who are assisted by researchers in a class in the biology education study program will learn how to utilize the shrimp shells waste. Students will then work in small groups to design a research on how to make chitosan from shrimp shells and test the effectiveness of chitosan as a natural preservative for processed meat by using an organoleptic test. The organoleptic tests include four aspects, namely taste, color, aroma, and texture. Tests were carried out using chitosan with a concentration of 1.5% and with an observation time of 5 days. Finally, students with researchers prepared a RBL-STEM report regarding the use of chitosan from shrimp shell waste together with the level of the effectiveness of chitosan as a natural preservative for processed meat.

3.1.3 *Lerning Objective*

This RBL-STEM learning will enable students to develop knowledge and skills in the following fields of Science, Technology, Engineering and Mathematics.

Sciences - Students are expected to:

- Understand the potential of shrimp shells waste that can disrupt the environment if we leave it.
- Develop an understanding of the properties of chitosan including its chemical characteristics and structure.
- Understand how to get chitosan from shrimp shells.
- Develope the function of chitosan as a natural food preservative.

Technology - Students are expected to:

- Use a web browser to record the superiority of shrimp shells as a potential alternative for natural preservatives for processed meat.
- Use a web browser to find recent studies related to shrimp shells as an alternative to natural preservatives for processed meat.
- Use the YouTube channel to find out how to make chitosan from shrimp shells.
- Develope a learning video using the camtasia video maker to show a turorial for chitosan-making and its use as an alternative to natural preservatives for processed meat.
- Utilize word processing application software and data as well as infrential statistics software to determine the effectiveness of chitosan from shrimp shells as an alternative to natural preservatives for processed meat.

Engineering - Students are expected to:

- Testing the characteristics of obtained chitosan for deacetylation degree, ash content, and chitosan water content.
- Testing the effectiveness of chitosan as a natural preservative for processed meat using organoleptic techniques to determine the changes in taste, color, aroma, texture and bacterial content.
- Analyzing the chemical content used in the deproteination, deacetylation and demineralization processes, including the calculation of heating temperature and heating time in these processes.
- Mastering the use of practicum tools in laboratories for the development of chitosan as a natural preservative for processed meat using organoleptic techniques.

Mathematics - Students are expected to:

- Study the calculation of the volume of space objects and ratio theory in mathematics to see the content of chemicals used in the deproteination, deacetylation, and demineralization processes, including the calculation of heating temperature and heating time in these processes.

3.1.4 *STEM Concept Connections*

This RBL-STEM learning will enable students to depth the use Science, Technology, Engineering, and Mathematics concepts in solving real-life problems. The concept needed in the development of a framework of RBL in STEM are as follows:

Science - Students are expected to revitalize and use and related concepts:

- Chitosan and its chemical characteristics and structure
- Potential waste from shrimp companies related to neglected shrimp shells and exploration of the function of chitosan as a natural food preservative.

Technology - Students are expected to be able to revitalize and use and relate concepts:

- Using google browsing, google scholar, research gate, media channels including youtube to see the potential of chitosan as a preservative.
- Camtasia video maker application software and inferential statistical analysis application software for the effectiveness test.

Engineering - Students are expected to revitalize and use and related concepts:

- Using chitosan from shrimp shells through a process of demineralization, deproteination, and deacetylation through the laboratory

Mathematics - Students are expected to revitalize and use and related concepts:

- The formula for the volume of space objects and the concept of ratio to measure the chemicals used in the demineralization, deproteination, and deacetylation processes, including the calculation of heating temperature and heating time in these processes.

Material Used

Tools		Materials
- Scale/Weight	- Bunsen stand	- Shrimp Shells
- Blender	- Bunsen	- HCl
- Sieve	- Mixer	- NaOH
- Basin	- Filter paper	- Aquadest
- Beaker glass	- Spoon	- Spirtus
- Measuring	- Oven	
- cup	- Pan	

3.2. *RBL Activities on Chitosan STEM Education*

In this section, we will discuss one by one the six stages of the RBL learning model using the STEM approach. These six stages will illustrate how student activities in learning with the RBL model together with the STEM approach related to the use of chitosan as alternative natural preservatives for processed meat. Based on Figure 5, the first stage (SCIENCE) is proposing the fundamental problems related to the abuse of artificial preservatives. The activities carried out by the lecturers in the first stage are asking the students about their awareness of the existence of artificial preservative abuse. The lecturer will also ask about their knowledge about chitosan from shrimp shells. For more details, see Table 1.

Table1. The RBL activities on Chitosan STEM Education of the first stage

STAGE	ACTIVITY
(1) Posing problem on some basic problems related to the abuse of artificial preservatives (SCIENCE)	1. The lecturer asks students if they know what food preservatives are? How many types of food preservatives are there? 2. Does the lecturer ask whether the students know the negative effects of preservative abuse in food? The lecturer presents a video about the misuse of dangerous preservatives in food. 3. The lecturer asks students if they know what chitosan is? Where does it come from? And what does it do? 4. The lecturer will then ask the students "If you can make chitosan as a natural food preservative, what will you do?" 5. The lecturer and students develop an understanding of the properties of chitosan including its chemical characteristics and structure

The learning activities RBL model with the STEM approach at the second stage (ENGINEERING) are developing breakthroughs related to chitosan, from shrimp shell waste, as a natural preservative for processed meat. The activities carried out by the lecturer in the second stage were guiding students to discuss breakthroughs on how to use shrimp shell waste to be utilised as chitosan. The Lecture also asks students to identify the tools and materials needed to make chitosan. For more details, see Table 2.

Table 2. The RBL activities on Chitosan STEM Education of the second stage

STAGE	ACTIVITY
(2) developing breakthroughs related to chitosan, from shrimp shell waste, as a natural preservative for processed meat. (ENGINEERING	1. The lecturer guides students to discuss breakthroughs on how to use shrimp shell waste to be used as chitosan. 2. The lecturer guide students to understand how to get chitosan from shrimp shells. 3. Developed the function of chitosan as a natural food preservative. 4. The lecturer asks students to identify what tools and materials are needed to extract chitosan from shrimp shell waste.

The learning activities by integrating the RBL model in the STEM approach on the third stage (TECHNOLOGY) are collecting data related to chitosan content and benefits through web browsing and other media channels. This is important before the research activities on chitosan as an alternative to natural preservatives for processed meat. The researcher also develops a tutorial by using a video maker. For more details, see Table 3.

Table 3. The RBL activities on Chitosan STEM Education of the third stage

STAGE	ACTIVITY
(3) Collect data related to chitosan content through web browsing, and other media channels (TECHNOLOGY)	1. Students under the guidance of lecturers carry out data collection activities related to chitosan content and chitosan functions. 2. Data collection related to chitosan is carried out by browsing scientific journals/articles via the internet or other media. 3. Use a web browser to record the benefits of shrimp shells as a potential alternative for natural preservatives for processed meat. 4. Use a web browser to find recent studies related to shrimp shells as an alternative to natural preservatives for processed meat. 5. Use the Youtube channel to find out how to make chitosan from shrimp shells. 6. Developed a learning video using the camtasia video maker to show a tutorial for chitosan-making and its use as an alternative to natural preservatives for processed meat.

The learning activities by using the RBL model with the STEM approach at the fourth stage (ENGINEERING) are making chitosan from shrimp shell waste by using laboratory equipment. The activities carried out by lecturers and students in the fourth stage was practicum to make chitosan from shrimp shells in the laboratory through demineralization, deproteination, and deacetylation processes. For more details, see Table 4.

Table 4. The RBL activities on Chitosan STEM Education of the fourth stage

STAGE	ACTIVITY
(4) Making chitosan from shrimp waste by using demineralization, deproteination, and deacetylation laboratory equipment (ENGINEERING)	1. Students prepare tools and materials that will be used for practicum. 2. Students carry out practical activities to make chitosan from shrimp shells. 3. To make chitosan first, we wash the shrimp shells thoroughly, drying the shrimp shells by drying them under the sun or in the oven, smoothing them in a blender, then carry out the demineralization process, the deproteination process, and the deacetylation process. 4. Testing the characteristics of obtained chitosan for deacetylation degree, ash content, and chitosan water content. 5. Testing the effectiveness of chitosan as a natural preservative for processed meat using organoleptic techniques to determine the changes in taste, color,

STAGE	ACTIVITY
	aroma, texture, and bacterial content. 6. Analyzing the chemical content used in the deproteination, deacetylation and demineralization processes, including the calculation of heating temperature and heating time in these processes. 7. Mastering the use of practicum tools in laboratories for the development of chitosan as a natural preservative for processed meat using organoleptic techniques.

The learning activities using the RBL model with the STEM approach at the fifth stage (MATHEMATICS) are conducting organoleptic tests and bacterial tests. The students are also testing the effectiveness of chitosan as a natural preservative for processed meat. For details, see Table 5.

Table 5. The RBL activities on Chitosan STEM Education of the fifth stage

STAGE	ACTIVITY
(5) Performing organoleptic tests and bacterial tests (MATHEMATICS)	1. Testing the effectiveness through organoleptic testing for the changes in color, taste, aroma, and texture of processed meat and includes conducting a bacterial test by using mathematics 2. Students record data on the results of organoleptic testing and bacterial testing. 3. Students also analyze the calculation of the volume of space objects and ratio theory in mathematics to see the content of chemicals used in the deproteination, deacetylation, and demineralization processes, including the calculation of heating temperature and heating time in these processes

The learning activities by using the RBL model with the STEM approach at the six-stage (RBL REPORT) are presenting the results of students' research related to the natural preservative for processed meat. The lecturer also observes the students' creative thinking skills by using observation sheets and test instruments. For more details, see Table 6.

Table 6. The RBL activities on Chitosan STEM Education of the six-stage

STAGE	ACTIVITY
(6) Presenting the results of on students research related to the natural preservative for processed meat(RBL	1. Students carry out presentations on the results of practicum or research that have been carried out. 2. The presentation is done by using a PowerPoint application or other similar application. 3. They should present the result in front of the class and a question and answer session or class discussion is provided.

STAGE	ACTIVITY
REPORT)	4. Lecturers evaluate and clarify all results of student's research activities. 5. Lecturers make observations of students' creative thinking skills by using observation sheets and test instruments. 6. The lecturer analyzes students' creative thinking skills.

4. Discussion

Considering the results of the above research, we can understand that the six stages of the RBL model and STEM learning process can produce a feasible learning activity to be carried out in the classroom or laboratories. Starting from the first stage to the sixth stage, there are active activities that will be carried out by students in the class or laboratory. They will research in the learning process related to the use of chitosan as an alternative to natural preservatives for processed meat.

With the existence of RBL Activities on Chitosan STEM Education, lecturers can then follow up to develop RBL learning materials with a STEM approach in improving students' creative skills to solve the problem of using chitosan as an alternative material for natural preservatives for processed meat.

The development of teaching materials can be developed by using a 4D (Define, Design, Development, and Disseminate) model. The development of teaching materials will be in the form of a syllabus, teaching and laboratory activities plan, assessment instruments, learning media, or monographs. Furthermore, we will apply the teaching materials in the classroom or laboratory to analyze the students' creative skills

The use of the RBL learning model with the STEM approach will potentially improve improve students' creative thinking skills through the process of solving problems in everyday life through scientific methods, namely the use of chitosan as an alternative to natural preservatives for processed meat. Why do we use chitosan, since we need to avoid such dangerous preservatives include formalin and borax. The side effects of eating foods containing borax and formalin are including irritation of the digestive tract, irritation of the skin and eyes, nausea, headaches, severe pain in the upper abdomen [6]. Taking borax in the long term can cause kidney disease, circulatory system failure, and death. Even, taking 5-10 grams of borax can cause shock and death in children [8]. Troughout this research, we will educate students to use natural preservatives, namely chitosan obtained from shrimp shells.

Through the RBL learning model with the STEM approach, students are trained to make chitosan from shrimp skin, which will later be used as as natural food, preservative for processed meat. The learning steps that need to be carried out consist of six stages, namely: (1) Posing problems related to artificial preservative abuse (SCIENCE); (2) Developing breakthrough by using chitosan from shrimp shell waste as a natural preservative for processed meat (ENGINEERING); (3) Collecting data related to chitosan benefits through web browsing and other media channels (TECHNOLOGY); (4) Making chitosan from shrimp waste with laboratory equipment of minimized, deproteinated, acetylated (ENGINEERING); (5) Conducting organoleptic tests and bacterial tests by using geometry and comparison, statistic theory (MATHEMATICS); and (6) Presenting the results of research and prediction students' creative skills by using observations and test instruments.

5. Conclusions

Research-Based Learning (RBL) with the Science, Technology, Engineering, and Mathematics (STEM) approach requires a comprehensive planning process. One aspect that we need to explore is the science problems. We have proposed in this study that we have a problem with shrimp shell waste as well as preservative abuse for food, meat, and vegetables. To educate students to resolve the problems, we need to integrate RBL-STEM in the process of learning either at the school level and university level. We have developed the framework of RBL in STEM together with the RBL activities

on chitosan STEM education obtained in this study. By this result, we can use the framework of RBL learning activities on chitosan STEM education in developing the teaching and learning materials for further study. Furthermore, future research is the implementation of the learning materials containing the RBL activities on chitosan STEM education and its affect on the student's creative thinking skills.

Acknowledgments

Any attempt at any level cannot be satisfactorily completed without the support from the Combinatorial Education and Research-Based Learning (CEREBEL) Research Group, FKIP University of Jember of the year 2021.

References

[1] Anderson L &Krathwohl D R 2001 *A Taxonomy for LearningTeaching, and Assessing. A Revisionof Bloom's Taxonomy of EducationalObjectives* New York Addison Wesley Longman Inc

[2] Cesar G A *et al* 2020 Creativity and Innovation Skills in University STEM Education:The CHET Project Approach *6th International Conference on Higher Education Advances (HEAd'20)*UniversitatPolit`ecnica de Val`encia

[3] Crispin D E Jr*et al* 2019 Linear Equations in Two Variables STEM Education Learning Activities: Developing the Household Power Consumption Calculator App. International Annual Meeting on STEM Education (I AM STEM) IOP Conf Series *Journal of Physics Conf Series***1340**(2019)

[4] Dafik 2015 *Graph Theory, Application and Growth of High Level Thinking Skills* Jember: Jember State University

[5] Department of Marine Affairs and Fisheries 2012 Marine and Fisheries (online) accessed from https://www.jemberkab.go.id/kelautan-dan-perikanan/ on 20 February 2021

[6] DevianaA 2015 Boraks Retrieved from http://www.academia.edu/31109269/BORAKSon February 20, 2021

[7] Holmegaard H T 2015 Performing a choice-narrative: A qualitative study of the patterns in STEM students' higher education choices *International Journal of Science Education***37**(9) 1454–1477

[8] Jayawardana H B A &Afandi A 2019 The Usage of Chitosan from Shrimp Waste as Natural Preservative for Fish Cilok (Traditional Food in Indonesia) *Indonesian Journal of Science Education (IJOSE)* **3**(1)

[9] Jenkins A 2004 *A Guide to the Research Evidence on Teaching-Research Relations* Oxford: Oxford University

[10] Ministry of Education and Culture 2020 Guideline Book for Learning Freedom– freedom Campus Jakarta: Directorate General of Higher Education

[11] Ningrum*et al* 2020 The students' problem-solving abilities in science, technology, engineering and mathematics (STEM) based on lesson study for learning community (lslc) *Journal of Physics: Conference Series***1538** (2020) 012088

[12] Ridlo Z R, Dafik, &Nugroho C I W 2020 The Effectiveness of Implementation Research-Based Learning Model of Teaching Integrated with Cloud Classroom (CCR) to Improving Critical Thinking Skills in an Astronomy Course *Journal of Physics: Conference Series*

[13] Statistics-KKP 2021 Fishery Production accessed from https://statistik.kkp.go.id/home.php?m=total&i=2#panel-footer on February 13, 2021

[14] Suntusia, Dafik, &Hobri 2019 The Effectiveness of Research-Based Learning in Improving Students Achievement in Solving Two-Dimensional Arithmetic Sequence Problems*Internasional Journal of Instruction* **12**(1) 17-32

[15] Tsupros N, Kohler R, &Hallinem J 2009 STEM Education: A Project to Identify The Missing Components. *In Intermediate Unit 1 Center for STEM Education and Leonard GelfandCenter for Service Learning and Outreach Carnegie Mellon University* (1)1–3

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