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Development of Functional Food Project Learning Tools for Food Chemistry Course

Nova Kurnia[1*], Liliasari[2], Dede Robiatul Adawiyah[3], and Florentina Maria Titin Supriyanti[2]

[1]Department of Chemistry Education, Faculty of Science, Engineering and Applied, Universitas Pendidikan Mandalika, Jalan Pemuda No. 59A Mataram, West Nusa Tenggara, 83125, Indonesia

[2]Natural Science Education, School of Postgraduates, Universitas Pendidikan Indonesia, Jalan Setiabudhi No. 229 Bandung, West Java, 40154, Indonesia

[3]Departement of Food Science and Technology, Faculty of Agricultural Technology, IPB University, Jalan Raya Dramaga Bogor, West Java, 16002, Indonesia

[*]E-mail: novakimia88@yahoo.com

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Abstract

This study aims to develop functional food project learning tools for the food chemistry course. This project learning tools consist of an implementation guide accompanied by a project appraisal rubric. The development of learning tools was based on the Dick and Carey model with three stages: needs analysis, development, and validation. The needs analysis shows an increase in non-communicable diseases in Indonesia and the world. Functional food has not been taught in food chemistry courses and the abundance of local food in Lombok Island with its various functional potency. The development stage involves designing project instructions accompanied by an assessment rubric. Two experts in food chemistry carried out the validation stage of the project learning tools. The instrument used was a questionnaire related to the suitability of the project objectives with the learning outcomes of food chemistry, the clarity of project-based learning syntax, the relevance of project topics to Lombok food, aspects of the language used, and an assessment rubric. The results show that all validated aspects are accepted with a few notes which have been further improved. Thus, the project learning tools can be used for functional food projects in food chemistry courses.

Keywords: functional food, project-based learning, project learning tools

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1. Introduction

One of the challenges in food chemistry in the 21st century that should be concerned about is the increasing prevalence of non-communicable diseases (NCDs) (Rychlik, 2015). Data of riskedas 2018 recorded an increase in NCDs when compared to 2013 for cancer, stroke, kidney, and diabetes mellitus (Kementerian Kesehatan RI, 2018). In fact, according to a release from WHO (2018), every year, NCDs kill 41 million people, equivalent to 71% of all mortality globally. This disease is chronic, and the sufferers sometimes do not realize it when they have tested positive for it. Unhealthy lifestyles such as physical inactivity, nicotine addiction, alcohol use, and unhealthy diets are the main factors that accelerate NCDs.

Regarding the consumption of food with less nutrition, people prefer to consume it for their main consumption. Food with less nutrition is generally known as junk food and fast food. As is known, junk food does not even contain very few nutrients but contains high calories, salt, and fat, such as candy, ice cream, snacks, and

soft drinks (Kavle et al., 2014). Meanwhile, fast food is ready to eat and is served shortly after being ordered. Some types of fast food are high in calories and low in nutritional value, but other types such as salads have high nutritional value and are low in calories (Fuhrman, 2018; Smith, 2006). Improving the diet, avoiding foods that can trigger NCDs, and education related to their negative impacts are steps that can be taken to prevent NCDs.

So far, efforts to improve health are generally only through the fulfilment of basic nutrients. However, some non-nutritional compounds such as dietary fibr and various polyphenol compounds from fruits and vegetables have biological activities good for health. For example, many non-nutritional compounds act as antioxidants, anti-inflammatory, anti-cancer, and anti-diabetes (Bontempo et al., 2015; Cassidy et al., 2018; Lin et al., 2018). The ability of non-nutritional compounds from a food material then becomes the physiological and functional functions they contain. Along with that, there is a trend in choosing foods that are filling and maintaing health and preventing NCDs and degenerative diseases (Ozen et al., 2012).

Functional food is a food that provides physiological health benefits beyond the benefits of basic nutrients such as carbohydrates, proteins, fats, vitamins, and minerals. The term functional food was introduced in Japan around the 1980s. By the Japanese Ministry of Health and Welfare, in 1991, the label "Food for Specified Health Use" (FOSHU) was designated as a regulatory system for functional food (Shimizu, 2012). This product has also penetrated Indonesia, shown by various types of functional food development utilizing local natural resources such as soybeans, sweet potatoes, red beans, white corn, sorghum, eel oil, and so on (Darawati et al., 2016; Noviasari. et al., 2015; Supriyanti et al., 2015).

Food chemistry courses can be a way of introducing functional food to preservice chemistry teachers. The results of observations at the higher education in Mataram City also that functional food had never been included in courses on food chemistry. Bioactive components or compounds that are the basis for fully functional food development components in food ingredients (Andarwulan et al., 2012; Atef & Ojagh, 2017). Previous studies have shown that the richness of natural resources around and food culture of Lombok Island holds potential as a source of learning functional food through a food chemistry course (Kurnia et al., 2016). This will then add a new dimension to food chemistry by presenting functional food topics based on local food culture.

Project-based learning is known to be effective in applying real-world and current issues topics. Providing opportunities for students to work and research independently will make learning meaningful, improve students' problem-solving, thinking, and communication skills (Davis et al., 2017; De Ios Santos et al., 2014; Kammler et al., 2012). Considering that project-based learning requires a fairly long time (weeks), a project implementation tool is needed. Therefore, the development of functional food project tools is then indispensable. In this tool, there are project instructions that become signposts for project implementation to follow the expected objectives. Also, this tool contains a project assessment rubric as an evaluation tool. Through a good rubric, the performance or product in carrying out the project can be measured effectively.

2. Research Method

The research method used was research and development (Dick & Carey, 2015). This research consists of 3 stages, namely, 1) the needs analysis stage, 2) the development stage, and 3) the validation stage (Figure 1). The needs analysis stage involves carrying out the latest issues in the development of food chemistry, curriculum studies, and the learning process of food chemistry and field studies on Lombok food culture. The development stage is designing a project tool in which there is also an assessment rubric. Meanwhile, the validation stage is validating the functional food project tool which conducted by expert validators. The experts who become the

validators of this project are two lecturers of the food chemistry course. The instrument for validating this tool is a questionnaire that contains a list of questions related to, among others, the coherence of project objectives with learning outcomes, clarity of syntax from PjBL, linkages with Lombok food, language, and appropriateness of the assessment rubric. The results of the validation were then collected and analyzed descriptively.

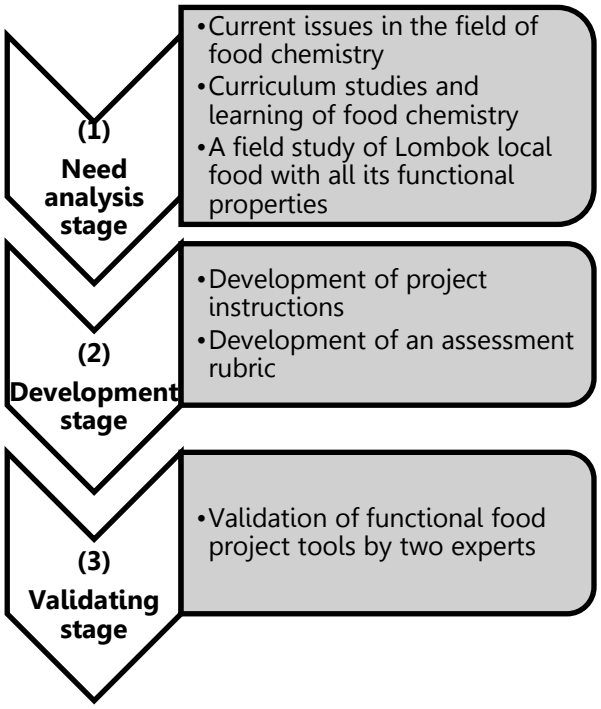

Figure 1. Research and Development Steps

3. Result and Discussion

3.1. The Needs Analysis Stage

The needs analysis stages showed several results, including:

a) The concept of functional food has never been carried out in food chemistry courses so far. Instead, courses materials focus on the macro components of food (water, carbohydrates, proteins, and lipids) and micro components of food (vitamins and minerals). In contrast other components known as non-nutritional substances in food ingredients have health benefits in functionality but have not become part of the learning material. Also, the development of functional food in Indonesia, which began to grow with its various innovations, was strengthened by establishment a scientific forum, namely *Perhimpunan Penggiat Pangan dan Nutrasetikal Indonesia (P3FNI)* in 2015.

b) Current issues in food chemistry in the future include the aspect of food safety as a major part of the world food trade and an increase in cases of NCDs, one of which is due to the intense consumption of fast food and junk food. However, in this case, the researchers focused more on cases of NCDs due to unhealthy diets, which are a latent and worrying danger. Therefore, the food safety aspect has been discussed in another section of the lecture on food chemistry. This is also in line with one of the targets of the 2030 Agenda for Sustainable Development to ensure healthy lives and promote well-being for all ages.

c) Lombok traditional food, which is so diverse in the form of dishes, snacks, and drinks such as ares, *bebalung, pelecing kangkung, cengeh, sate pusut, ayam Taliwang, poteng reket,* and coffee have potential functional properties and can be used as a source of learning the food chemistry (Kurnia et al., 2016; Sukenti et al., 2016). So far, Lombok local food as part of culture has never been appointed to food chemistry. However, the culture of a region can be a way to teach global issues effectively. Besides that, it can foster enthusiasm for learning and an attitude of loving culture as an ancestral heritage (Atmojo, 2015).

3.2. The Development Stage

The functional food project tool was developed in the form of a simple module of seven pages. This functional food project tool consists of several components, including title, objectives, theoretical studies, student project proposal format, assessment format, assessment rubric, and references (Figure 2). The assessment rubric includes an analytic rubric adapted from Allen & Tanner (2006). The rubric consists of four aspects of assessment, namely the referenced concept, understanding of analytical procedures, understanding of bioactive compounds, and product creativity. The assessment aspect is

adjusted to the concept of functional food and its development, namely bioactive compounds, development techniques, and product innovation (Bigliardi & Galati, 2013; Roberfroid, 2000). Each aspect has compiled a description of its assessment in stages, from the lowest score to the highest.

Figure 2. **Cover of Functional Food Project Tool**

The performance rubric and project products are prepared with four aspects: the concept referred to, understanding the analytical procedure, understanding bioactive compounds and product creation. Each aspect has compiled a description of its assessment in stages, from the lowest score to the highest.

3.3. Validation Stage

The validation stage involves two experts who are lecturers of the food chemistry course. The validation carried out shows that the functional food project guide is suitable for use with improvement. The aspects that are validated are: a) the suitability of the project objectives with the learning outcomes of the food chemistry, b) project-based learning steps are clearly illustrated in project activities, c) project topics related to Lombok local food, d) the project guide language can be understood by easy, and e) the scoring rubric can be understood. The full validation results are presented in Table 1.

3.3.1. The Suitability of the Project Objectives with the Learning Outcomes of the Food Chemistry Course

As an innovation in the food chemistry course, this project cannot be separated from the learning outcomes that have been prepared initially; namely, students can develop functional food from Lombok food and natural resources. Learning outcomes show the abilities obtained by students through the internalization of knowledge, attitudes, skills, competencies, and accumulated work experience (Dirjen Belmawa, 2018). Work experience through this project then becomes one way to fulfill these learning outcomes. Therefore, the project objectives must be suitable for the learning outcomes. The validation results show that the project objectives have met conformity with the learning outcomes of food chemistry learning.

3.3.2. Project-Based Learning Steps Are Clearly Defined In Project Activities

The validators stated that the steps of project-based learning were reflected as a major part of the functional food project activity. The validation results show that the project work guide already describes the steps of project-based learning. In general, the steps of this functional food project are:

1) Lecturers ask driving questions to students before carrying out project activities. For example, the driving question in this functional food project is, "How can you be able to develop functional food from Lombok food or local resources?". These driving questions are open-ended and challenging so that students will be enthusiastic about working on project assignments (Diawati et al., 2018).

2) The student group prepares a functional food project proposal that refers to the driving question. The project proposal systematics must be following those stated in the project guidelines.

3) Student groups carry out project activities during a predetermined time for 14 days.
4) Student groups compile project results in the form of functional food products and then present them.

Table 1. Validation Results of Functional Food Project Tools

Rated aspect	Expert 1 (Yes/No, along with suggestions if any)	Expert 2 (Yes/No, along with suggestions if any)
The suitability of the project objectives with the learning outcomes of the food chemistry course	Yes	Yes
Project-based learning steps are clearly illustrated in project activities	Yes	Yes
Project topics related to Lombok local food	Yes	Yes
The project guide language can be easily understood	Yes. Add a sub background to the project report format.	Yes
The scoring rubric can be understood	Yes. It is necessary to review the aspects being assessed which are truly essential.	Yes. Improve the aspects assessed (include an understanding of bioactive compounds)

3.3.3. The Project Topic Is Related To Lombok Food

Validating results stated that the topic of the functional food project being developed was directly related to Lombok food. This is very clear from the driving question sentence. Therefore, the functional food project is very contextual and reflects local culture as a source of learning. Various foods from Lombok such as *ares, bebalung, pelecing kangkung, sate pusut, cengeh,* and surrounding natural ingredients become project areas excavated and developed into functional food (Kurnia et al., 2016). The use of local culture or household materials will make the project cheap and affordable for students but still have a scientific side.

Cultural values and local wisdom are a source of inspiration for science learning (Suastra, 2017). This is also in line with one of the missions of chemistry education, which is to create a comprehensive and real-world chemical knowledge center. Hence, learners need to connect their chemical knowledge with their daily life or culture (Barke et al., 2013). Therefore, the lecture program developed must be able to pass on culture from one generation to the next as a form of sociological foundation (Dirjen Belmawa, 2018).

3.3.4. Project Instruction Language Can Be Understood Easily

The language aspect is one of the main parts in assessing a text teaching material or chemistry lab guide (Rusiani & Lazulva, 2017). Clarity of sentences and good readability will facilitate the running of project activities carried out. Based on the validation results, the functional food project guide developed can be easily and clearly understood. However, some suggestion to add a background section to the functional food project manual for clarity in carrying out project activities.

3.3.5. The Assessment Rubric Can Be Understand

Rubric development begins with analyzing the skills required to carry out the project to asses as the assessed aspect. The same thing was done by Chen et al. (2013) when developing a rubric for assessing skills to conduct experiments in organic chemistry courses. A good rubric will make it easier for students to

know the purpose of their assignments and focus on their performance (Andrade, 2005). Therefore, the rubric is an assessment tool and teaches students the main elements they must master in a particular topic (Logan & Mountain, 2018). In addition, knowing the aspects being assessed will help students understand the core concepts of the topics they are studying.

Based on the experts' results, this rubric can be understood and meets the standards of a rubric. However, there are inputs on the aspects assessed, namely the need to consider including the concept of bioactive compounds. This is very reasonable because bioactive compounds are one of the bases for developing functional food. Bioactive compounds can be in peptides the form of peptides, food fiber, or secondary metabolite compounds such as phenolic compounds (Legua, 2016; Macagnan et al., 2016). Each group does not necessarily do an experiment, but they can be done through scientific articles indexed by Scopus or searching for internet databases such as PubChem (De Ios Santos et al., 2014; Minkiewicz et al., 2015).

Another suggestion is to consider using one of the assessed aspects, namely, understanding the analysis procedure or understanding the implementation of the analysis. Considering that the two aspects assessed have the same meaning, the researchers changed the aspects assessed by understanding the implementation of the analysis into understanding bioactive compounds (Table 2).

Table 2. A Fixed Rubric Based on Expert Suggestions

Before validation

Rated Aspect	4	3	2	1
referenced journal	Complete, with the number of references above 5 journals	quite complete, the journals referred to are between 4-5 journals	Incomplete, the journals referred to are between 2-3 journals	Less than 2 referenced journals
understanding of analytical procedures	able to explain the principles of analysis and the function of chemicals, treatment in the analysis very well	Explain the principles of analysis and the function of chemicals, treatment in analysis well	Explain the principle of analysis and the function of chemicals, treatment in the analysis in doubt	incapable of analytical principles and chemical functions, treatment in analysis
understanding the implementation of analysis	conduct analysis before product design very carefully	perform analysis before product design carefully enough	conduct analysis before product design is less thorough	do not do analysis before product design
product creativity	the formula designed is the result of the synthesis of new and original functional food products produk	The formula designed is not new, but the characteristics are not dominated by old products	The formula designed is not new, but its characteristics are still dominated by old products	Not designing functional food product formulas

After validation

Rated Aspect	4	3	2	1
referenced journal	Complete, with the number of references above 5 journals	quite complete, the journals referred to are between 4-5 journals	Incomplete, the journals referred to are between 2-3 journals	Less than 2 referenced journals
understanding of analytical procedures	able to explain the principles of analysis and the function of chemicals, treatment in the analysis very well	Explain the principles of analysis and the function of chemicals, treatment in analysis well	Explain the principle of analysis and the function of chemicals, treatment in the analysis in doubt	incapable of analytical principles and chemical functions, treatment in analysis
understanding of bioactive compounds	explain the bioactive compounds of a material very well and completely along with the potential that accompanies it	explain the bioactive compounds of a material well and its potential	explain the bioactive compounds of a material quite well and their potential	unable to explain the bioactive compounds of a material and its potential
product creativity	the formula designed is the result of the synthesis of new and original functional food products produk	The formula designed is not new, but the characteristics are not dominated by old products	The formula designed is not new, but its characteristics are still dominated by old products	Not designing functional food product formulas

The functional food project tool is further improved according to suggestions from the validator to be used for food chemistry courses. This project tool can be an independent teaching material for students, making it easier for their learning. This finding in line with Paristiowati et al (2019) that well-developed teaching materials will greatly help students understand the material in chemistry learning. In addition, this project tool can act as an evaluation tool for student performance in project-based learning.

According to the various components of this project tool, the functional food project tool has the characteristics such as responsive to current issues in food chemistry and based on Lombok culture. Chemistry learning must be able to present relevance to the development of everyday life and overcome social problems

that occur in real life (Burmeister & Eilks, 2012). The utilizing of Lombok's food in this tool provides a new dimension in food chemistry courses as a learning resource that is low-cost and easy to obtain. Culture and local wisdom are sources of inspiration for science learning (Suastra, 2017).

4. Conclusion

The functional food project tools for the food chemistry course have been successfully developed and validated. The validation results show that the functional food project tools are suitable for pre-service chemistry teachers in developing functional food by utilizing Lombok local food and natural resources around it.

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