

Development of virtual laboratory of food microbiology-based websites

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Abstract. Virtual Laboratory is a computer-human interaction format where simulated environment labs and users can interact as if they were in a real laboratory. The virtual lab can be opened anytime and anywhere. Furthermore, it allows learners to interact easily, especially in practical activities. This study aims to develop a virtual lab-based website to support the learning process of a Food Microbiology practice. The research method used in the development of Food Microbiology Laboratory is a Model of ADDIE (Analysis, Design, Development, Implementation, and Evaluation). In the development process, the product was validated by a team of media experts and material experts using a validation questionnaire. The result of media and material experts' validation indicates that the virtual laboratory of Food Microbiology based-website is feasible to be a medium of learning. The result of the test on the implementation is positively responded by students. The students' questionnaire results in 79,33% of assessment which indicates a very good response to the developed product.

1. Introduction

The development of education is now entering an era marked by continuous technological innovation that requires an adjustment of education system which is in accordance with work demands. Higher education is an after-secondary education that is designed to prepare learners to be part of a community with academic and professional skills that can create, develop, implement and optimize science and technology [1].

One indicator of the education qualities in college is students' learning achievement. This learning achievement can be seen from the academic value obtained by the students. This academic value is influenced by several factors, such as the process of teaching and learning. Teaching and learning process organized by the teacher is a factor that is very dominant influencing students' learning outcomes. Therefore, teachers always strive to organize a qualified learning process so that the students can achieve maximum learning achievement [7].

Food Microbiology is one of the subjects that must be attended by students of Food Engineering Program or Agricultural Processing Technology related to the supervision and testing of food quality



biologically both qualitative and quantitative. Food Microbiology Lecture aims to enable students to explain, analyze, and control food quality biologically.

The learning implementation of Food Microbiology is supported by classroom and practicum learning in Quality Control Laboratory. The learning Implementation of Food Microbiology which applies laboratory methods in the laboratory is an effort to relate theory and practice, increase students' interest and motivation to learn, improve students' misconceptions, and develop a students' critical thinking attitude [3] [4].

The learning implementation of Food Microbiology practicum in Quality Monitoring Laboratory still encounters many problems. The encountered problems are due to the limited facilities and infrastructure such as laboratory space, laboratory equipment, laboratory materials, and expensive laboratory operational costs. These problems can lead to a delay of students' practicum activities implementation because this situation is faced with a situation where the students have to wait for the available resources. In addition, students' experiment can be disrupted before it is terminated because the resource needs are shared. These problems will have an impact on the competence of the students because the competence of the students will not be fully owned in mastering a competency [5].

An alternative solution which is offered to overcome the limited resources problem is through the utilization of information technology and computers. A number of interaction forms can be generated through computer media such as presentation of practices and exercises, tutorials, games, simulations, inventions, and troubleshooting [6][7]. One of information technology and computers utilizations in learning is the development of virtual laboratories. A virtual lab is an interactive multimedia object. The interactive multimedia object consists of various heterogeneous formats including text, hypertext, sound, images, animation, video, and complex interactive graphics and new digital forms, with implicit or explicit learning purposes [8] [5] [9].

The virtual lab can provide challenges for students in solving problems. The virtual lab focuses on the actions of learners in a realistic setting. The virtual lab is an early success and momentum for the development of independent simulation elements, and now does the same for virtual world simulation [10]. Learning with computer-based virtual laboratories leads students to be more independent and improve their high-level thinking skills and the ability to communicate their ideas [11].

Based on the above background description, the purpose of this research is to develop a virtual laboratory model of Food Microbiology as an alternative solution for limited resources such as laboratory equipment and materials and experimental difficulties in the practice of Food Microbiology.

2. Research methods

The research method used in the development of Virtual Laboratory of Food Microbiology is Model of ADDIE (Analyzing, Designing, Developing, Implementing, and Evaluating). ADDIE is one of the most common models used to develop interactive multimedia learning media. ADDIE is a model developed from the ID model (Instructional Design) which is used for the purpose of developing the theoretical foundation of instructional design [12]. The step of virtual laboratory development in this research is conducted in accordance with the process step of ADDIE model. The process stages in the ADDIE model are as follows:

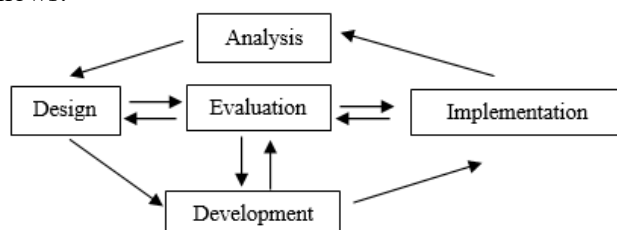


Figure 1. The ADDIE development model diagram.

3. Results and discussion

The last result of research development of this virtual lab media includes: 1. A learning media in the form of virtual lab using adobe flash software for simulation and web design using CMS opensource WIX. 2. An assessment of virtual lab study media products by material experts and media experts. 3. Students' responses to virtual lab media that had been made by spreading the questionnaire to 10 students Agroindustry Technology Education FPTK UPI. This development research used ADDIE development framework consisting of 5 stages, they were:

3.1. Analysis

Stage analysis is a process of defining what will be learned by users of the system. This stage can be known from the interview with Lecturer of Food Microbiology PTAg FPTK UPI. Based on the data obtained from the interview, it is attained that the laboratory of quality control of food has problems in the procurement of equipment and incomplete materials, especially for a Food Microbiology course. Nevertheless, facilities and infrastructure to support Information Communication and Technology (ICT) like computer laboratory, Liquid Crystal Display Projector (LCD projector), and internet network that can be used in learning activities are adequate. In addition, the researcher performed a needs analysis, problems identification, and task analysis by performing documentation studies, preliminary studies (interviews and observations), and literature studies (reviewing journals, scientific articles, and books) to obtain valid data that underlie the development of learning media.

3.2. Design

The development of this design is a virtual Food Microbiology laboratory. The steps to manufacture the product start from making flowchart, simulation board story, simulation and website layout design, asset creation, and material preparation. At this stage of the design, an evaluation of the design and the content of the product was conducted with the purpose of improving the developed product.

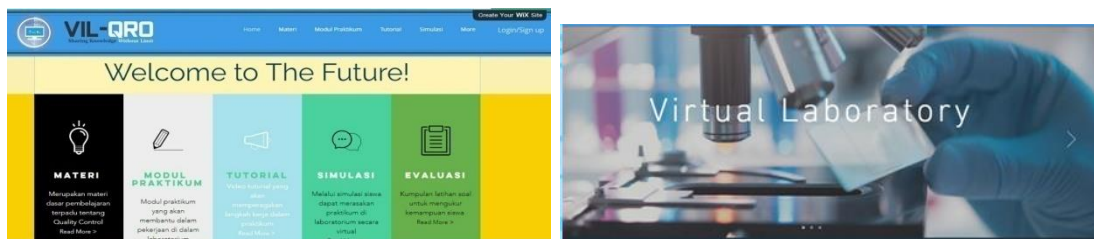


Figure 2. Main page.

3.3. Development

At this stage, a virtual lab was created using adobe flash software for simulation and web design was created using WIX which was then validated by a team of material and media experts.



Figure 3. Material page.



Figure 4. Module practicum and video tutorial.

Experts team validation was conducted by lecturers of Agroindustry Technology Education FPTK-UPI. Suggestions, feedbacks and comments obtained from expert team were then used for virtual lab repairmen. The validation by media experts declares that the virtual laboratory of Food Microbiology is suitable to be a medium of learning. Based on the assessment by media experts, there are some suggestions that were given, including:

Table 1. Expert advice media.

No.	Aspect	Advice
1.	Software engineering	a. An addition of menu "Module and Evaluation Question"
		b. An addition of left and right scroll bars on the tool and material view.
		c. A use of flip book software on Materials and Modules sections.
2.	Visual communication	a. An enlargement of Material Icons, Modules, Simulations, Tutorials, and Problems.
		b. A creation of reflected instructional medium V-Lab name, logo and tagline.
		c. An enlargement of writing font on the menu bar.

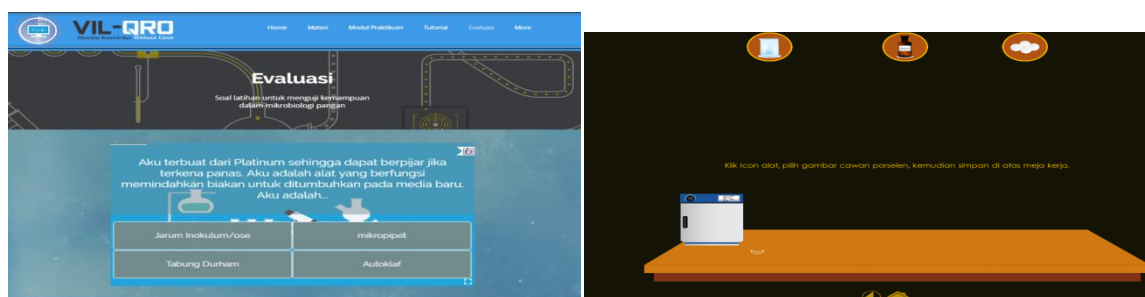
Validation by material experts was conducted twice with a conclusion that the virtual laboratory of Food Microbiology is feasible to be a medium of learning. Based on the assessment by the material experts, some suggestions were given such as the less obvious letters on the content of the material and the addition of samples on each material.

Table 2. Expert content suggestion.

No.	Aspect	Suggestion
1.	Learning	a. An addition of video or animation tutorials. b. An addition of interactive evaluation question. c. An addition of GLP and K3LH materials which especially related to Food Microbiology practice. d. An addition and clarification of practicum modules.

4. Implementation

A completion of the developed virtual laboratory was conducted by focusing on notes, suggestions and comments from media and material expert's validation to obtain the final product which was ready for trial. Trials were limited to small groups. To know the students' responses to the developed virtual laboratory, questionnaire of students' responses was shared.

**Figure 5.** Simulation and quiz.**Table 3.** Student response.

No.	Aspect	Results of Questionnaire
1.	Software engineering	75 %
2.	Visual communication	78 %
3.	Learning	85 %

Table 4. Student response.

No.	Aspect	Suggestion
1.	Software engineering	a. An accessible of virtual labs on android for easy access. b. A creation of offline virtual mode lab. c. An addition of audio to the names of tools, media, samples and work procedures.
2.	Visual communication	a. Naming the tool, media, and sample which will be selected. b. Giving the colour of transparent of glassware as well as the color of the media that grow according to the actual color. c. A selection of dark colors in the simulation background. d. More attractive website using bright colors. e. An enlargement and clarification of posts on materials, modules, simulations, tutorials, and questions.
3.	Learning	a. An addition of test sample. b. An Addition of any possibility that occurred during the test.

5. Evaluation

Evaluation is a process to see if the developed learning mediums is successful in accordance with the initial expectations or not. Evaluation can be done at every stage of development. This last evaluation is to know the students' response to the use of instructional media that has been declared eligible by expert team. This evaluation is a formative evaluation, as it aims for revision needs. After the implementation phase in conducting product trials, researchers obtained data in the form of a questionnaire. The data analysis of respondents' questionnaire result shows that most of the students like and are interested in the virtual lab media by providing a very good response. The suitability of the media in learning and the attractiveness of the practicum presented is able to make the students interested in studying the learning material that is provided and can help the students become easier in understanding the material through the practicum in the virtual laboratory.

6. Conclusion

Based on the research results, it can be concluded that the development of Food Microbiology virtual laboratory based-webs implemented the framework of ADDIE development. This development framework has 5 stages: Analysis, Design, Development, Implementation and Evaluation. In the development process, the product was validated by a team of media and material experts using a validation questionnaire. The result of media and material validation indicates that the Food Microbiology virtual laboratory-based website is feasible to be a medium of learning. The result of the test on the implementation is positively responded by students. The students' questionnaire results in 79,33% of assessment which indicates a very good response to the developed product.

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