The Needs of Developing E-Learning Based on Research Result of Energy-Efficient Materials Innovation Using Root Cause Analysis

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Abstract. This paper aims to analyze the level of need for the development of E-Book-based energy-saving wallcovering research materials to increase students' knowledge and motivation for innovation. Up to the present, the lecture materials related to energy-efficient buildings are only based on concepts from theory without any development of innovative research results. Ideally, lecturers provide lectures based on the results of their research. By studying the research results, lecturers will know how to motivate students to think innovatively. However, during pandemics learning activities must be done online. The students are still required to be able to develop their knowledge and be innovative. Online learning provides opportunities for lecturers to guide the learning activities by applying technology, which can be given through E-Books. Therefore, increasing students' knowledge and motivation for innovation can be obtained by doing needs analysis on the development of learning materials for energy-saving walls covering research based on E-Books. This research data was obtained through a questionnaire to several lecturers at the Civil Engineering Study Program in *Universitas Negeri Medan.* This study uses Root Cause Analysis in obtaining the needs analysis. This analysis examines layer by layer causes to get the main cause of the importance of learning development needs based on E-Book-based energy-saving wall covering research materials.

The identification results found several main causes of the importance of developing E-book-based energy-saving wall covering research materials.

Keywords: Root Cause Analysis · Learning Development · Research Materials · Energy-Efficient Buildings · Innovation

1 Introduction

One of the considerations for green building design is to reduce solar radiation entering the building, thereby reducing energy use for Air Conditioners (AC) [1]. The results of Bourdeau's research in 1999 [2] revealed that 50% of the energy absorbed in a building is only consumed by cooling equipment. Therefore, 30% of the total energy needed by a country is usually for housing. Based on these factors, energy use in buildings needs to be balanced by innovations that can save energy and are environmentally friendly, as in

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several countries. This concept can be applied to one of the building envelope materials, namely the wall. Walls need protection and insulation from the sun's heat to reduce the use of air conditioners.

Related to energy-efficient buildings that are environmentally friendly and in harmony with nature, it is very important to learn and understand Building Science. This science deals with the need for comfort and healthy buildings. Considering materials, architecture, environmental ecology, and economics are also significant. Therefore, ensuring thermal comfort in a building requires knowledge, engineering, and innovation. So far, teaching and learning have been carried out without any development and innovation. Therefore, student knowledge does not develop, and it does not motivate students to innovate. Thus, it is significant to improve learning related to energy-efficient buildings [3].

Government Regulation Number 65 of 2013 concerning Process Standards states that every educator is obliged to prepare a complete and systematic Lesson Plan. Thus, learning can be interactive, inspiring, fun, challenging, and motivating students to participate actively. Besides, it should provide students sufficient space for having initiative, creativity, and independence based on their talents, interests, and physical and psychological development. In line with the role of teachers in the Tri Dharma of Higher Education, according to Law number 12 of 2012 concerning Higher Education, article 12 paragraph (2), teachers as scientists have the task of developing a branch of science and/or technology through scientific reasoning, researching, and disseminating it. However, the current Covid-19 pandemic has had an impact on various sectors of life, including education [4]. The call by the minister of education that learning is done from home with distance learning [5]. It emphasizes that online learning must still provide meaningful learning experiences for students. Meaningful learning is meant by continuing to interact with students and provide guidance [6]. Therefore, the lecturers have the opportunity to be innovative in theory, pedagogical reasoning, and learning design related to online and distance learning [7]. In this regard, it is necessary to analyze and determine the need for the development of teaching materials for the e-book-based energy-saving wall covering research material.

2 Review of Related Literature

Ideally, teachers enrich learning materials with the results of their research and conduct learning based on those results. It supports that the learning model using research aspects will enable students to (a) develop research skills, (b) produce best practices, (c) and increase capacity as agents for change and improvement in their environment [8].

One of the efforts to develop students' knowledge and innovation on environmental problems is by developing environment-based learning. Researched the Application of Model Project-Based Learning on Integrated Science in Water Pollution [9]. This research proves that the development of integrated science learning can improve students'

mastery of concepts. Arce researched Project-based learning: application to a research master subject of thermal engineering [10]. The results of this study indicate that project-based learning is effective in facilitating the acquisition of student competencies. Kilinc conducted research entitled: Can project-based learning close the gap? Turkish student teachers and pro-environmental behaviors [11]. The research was conducted because of the gap between cognitive patterns and human behavior towards pro-environment. The findings of this study indicate that environment-based learning causes positive changes in participants' behavior regarding environmental protection.

3 Methodology

This study uses a survey design. Collecting the empirical data of this study is using a set of questionnaires. The questionnaire was distributed to lecturers of the building engineering education program at *Universitas Negeri Medan* to get feedback and suggestions. The questionnaire is divided into four sections. Those sections ask participants to assess and provide comments on the following areas: (i) undeveloped knowledge related to energy-efficient buildings, (ii) learning related to energy-efficient building innovation, (iii) learning related to motivation to innovate, (iv) learning from research results, (v) online learning related to motivation to innovate. Then an analysis was carried out using Root Cause Analysis (RCA) to obtain the level of need for learning development related to energy efficient building innovations. Then an evaluation is carried out for the results to become recommendations for the need for learning. The approach in this study follows the following framework (Fig. 1).

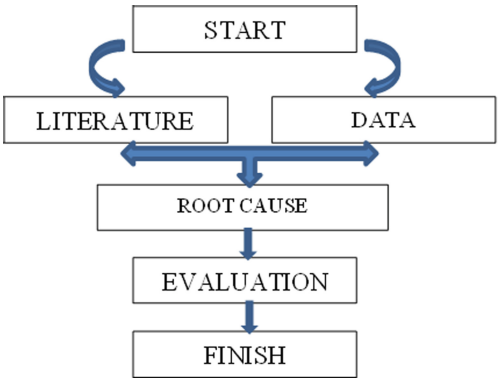

Fig. 1. Flowchart of the Research Process

4 Results and Discussion

In the era of globalization today, a nation that is unable to face progress in various fields will become left behind. The global information era allows one to get information quickly and easily from many sources. Education is the process of forming and developing reasoning, skills, and life morality based on human potential. Education is said to be of high quality if the learning process takes place effectively and helps students gain meaningful experiences for themselves. This demand also applies to distance learning [5] which is carried out while still providing a significant learning experience for students.

Education requires the ability to implement certain expectations and ideas to answer problems in life. Learning activities that can help solve life problems require skills, reasoning to connect facts, and opinions related to the problems at hand. Based on this fact, it is very important to develop energy-efficient buildings learning for distance learning. For this reason, it is necessary to analyze and find out how the level of need for the development of teaching materials for this e-book-based energy-saving wall covering research material is [12].

This needs analysis is carried out using Root Cause Analysis (RCA) [13]. RCA is a systematic analysis process to examine a problem from its root cause to ascertain the cause. The purpose of Root Cause Analysis is to identify the factors that contribute to causing problems in performance. The RCA process is carried out by examining the performance of the problem from the root cause layer by layer to a minimum of five layers to determine the main cause so that the need for solving the problem can be recommended.

The first step in using RCA is to identify the cause of the problem. In this study, the problem stems from the fact that students' knowledge in the Building Science course does not develop in understanding energy-efficient buildings related to innovations that can be carried out, especially during this pandemic. This cause is examined layer by layer by exploring the respondents' opinion to get the root cause.

Based on the results, the identified need is the importance of developing E-book teaching materials for learning Energy Saving Wall Coverings to increase students' knowledge and motivation towards innovation. Layer by layer of root causes that were examined for the performance of the problem to ascertain the root cause is shown in Table 1.

From the analysis based on layer by layer of the root causes of the problem, the main cause is obtained. From these results, the need must be done for learning development is to develop online learning materials based on research results to increase students' knowledge and motivation to innovate on energy-efficient buildings.

Table 1. Main Causes and Root of the Problem

Cause 1	Step to the root cause map	Recommendation
Students' knowledge and motivation do not develop regarding energy-efficient buildings	Students are only fixated on concepts and theories	Changing how the students think to develop their knowledge and motivation
Cause 2	Step to the root cause map	Recommendation
Learning activity about energy-efficient buildings is only in the form of concepts and theories	Students do not develop their thinking patterns to understand the knowledge development on innovation in responding to challenges in their surroundings	Changing students mindset to develop their knowledge of innovation
Cause 3	Step to the root cause map	Recommendation
Learning activity related to energy-efficient buildings did not motivate the students to do innovation	Learning activities did not motivate students to do innovation to face challenges in real life	Developing the learning of energy-efficient buildings towards innovation
Cause 4	Step to the root cause map	Recommendation
Learning materials towards energy-efficient buildings given are not based on research innovations result	Learning activity did not follow the research results that can increase students' knowledge and motivation for innovation to save environmental damage	Develop learning materials based on the result of the research
Cause 5	Step to the root cause map	Recommendation
During the covid-19 pandemic, online learning is needed to increase students' knowledge and motivation for innovation	Online learning did not increase knowledge and motivation for student innovation to save environmental damage	Develop online learning materials to increase knowledge and motivation to innovate

5 Conclusion

The analysis process with RCA is carried out by examining the performance of the problem from the root cause layer by layer. There are five layers needed before determining the main cause of the importance of developing online learning about energy-efficient building innovations. Based on the results of the analysis, the main cause in developing learning can be identified. The cause is that during the covid-19 pandemic, to increase students' knowledge and motivation towards innovation, online learning is needed. The level of need for the importance of developing online learning materials to increase knowledge and motivation to innovate is identified.

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