Design of Wireless Engine Diagnostic Tool with Raspberry *Pi* for Learning Media Vocational Education Teacher Candidates

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ABSTRACT

Practical learning is an important activity to improve the skills of prospective vocational education teachers. Supporting facilities have an essential role in the implementation of the practice. This study aims to analyze the learning media's needs for making wireless engine diagnostic tools with raspberry *pi*. The method used in this research is ADDIE. This research only reached the design stage. This study focuses on the needs analysis used in the development process. The research sample is in the form of an application layout design that will be developed. The instrument in this study was an assessment sheet in the form of a questionnaire regarding the feasibility of the design. Experts in the field of application development assess designs. Developing a wireless engine diagnostic tool with raspberry pi is needed to support learning for prospective vocational teachers. The design of learning media Design of the Wireless Engine Diagnostic Tool with Raspberry Pi can be developed for practical learning of vocational students. The results of the media feasibility test by media experts can be categorized as "very feasible" to continue at the development stage.

Keywords: Wireless Engine Diagnostic Learning, Media, Raspberry Pi

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INTRODUCTION

Engineering vocational learning in Indonesia is growing significantly [1]. So, the need for vocational education teachers to supply teachers in vocational high schools is the current focus. Vocational teacher candidates are prepared to become competent teachers. Changes in the learning scheme are thought to be detrimental to the learning process, particularly student learning outcomes [2][3]. Vocational education has the advantage of specific job-appropriate skills, which can make workers better prepared for the jobs they get and make them more productive.

The beginning of integrated efforts to develop vocational education in Pelita V is the first milestone in developing integrated vocational education in Indonesia [4]. Regulation of Nation Number 29 of 1990, there are 3 articles as a basis for developing vocational education [5]. Another effort is the cooperation of vocational education with the world of business and industry. Implementing dual system education through the "Link and Match" is a historic milestone for the government's initial efforts to involve industry in vocational education. Then with the establishment of the National Vocational Education Council (MPKN) and the formation of MPKN for the provinces. After the reformation order, the strategy for developing vocational education is to develop quality and relevance and foster some international standard Vocational Schools. Expansion and equity of access while still paying attention to the quality of education and improving Vocational Schools management by applying the principle of "Good Governance."

Facilities and infrastructure are other factors that determine the quality of Vocational graduates. Facilities and infrastructure such as buildings and other facilities support learning and teaching. Such as teaching aids and practice, laboratories, and vocational training centers as places for work practice for vocational schools are needed by students because they can bring students into a situation like in the world of work. The real. For this reason, it is also necessary to apply industrial work practices included in the Dual System Education framework to familiarize and introduce students to the real world of work. During industrial work practices, students rely on mastery of knowledge and guidance from the business world/industry carried out by instructors to provide explanations and guidance about the company and the tasks that must be carried out. Working in the real world is the application of skills acquired in school to new situations that require a lot of problem-solving abilities.

Therefore, learning in vocational schools should be directed at problem-solving skills. On the other hand, in the learning process at school, it is often found that teachers do not teach ways of solving problems correctly but require students to be able to solve problems automatically. The Covid-19 pandemic (corona virus disease-2019) is an acute

problem that has a multidimensional impact on the lives of all people in the world, including Indonesia [6]. After the Covid-19 pandemic, the role of learning media became necessary for optimizing classroom learning [7][8]. The Covid 19 pandemic has had an impact on the education sector [9][10][11][12][13][14][15][16].

The advancement of ICT has an impact on automotive technology [17][18][19][20][21][22]. Information and Communication Technology (ICT), often known as Information Communication Technology (ICT), is very important to master in the current era of globalization [23][24][25][26]. The computer is one of the media used in ICT because the computer has several functions, such as processing data, searching for material, presenting information in groups or individually, and other activities. In this modern era, the internet and intranet are necessary for anyone. Both generally play a dominant role in student life. Students can feel many benefits from using ICT in learning.

The history of emergence of ICT is after the combination of computer technology (both hardware and software) with communication technology in the mid-20th century. The two technologies are developing rapidly beyond other technology fields. Until the early 21st century, ICT was still experiencing various innovations. The internet is very supportive of information services related to education [27]. So that educational institutions or universities must

have facilities with ICT to support more effective and efficient learning [28]. Learning media is one of the keys to the implementation of adequate education. When learning media is used correctly in the learning process, it becomes a more effective and efficient support tool in achieving learning objectives [29][30][31][32].

Globalization is an economic engineering that has opened human life, and humans are essential to that openness. The motto of globalization is quality education. Changes in the economic structure from agriculture to industry will affect the nation's way of life and thinking. The growth of modern industry necessitates an increase in the number of technical personnel, both intermediate and professional. To adapt the program to the rapid development of technology, education and training must be prepared. In line with this, vocational education must be transformed to include a solid scientific education foundation.

The role of technology in industrial society necessitates the presence of people who are technologically savvy. The industrial society is not only literate, but also numerate. Developing and utilizing science and technology for developing countries will be successful if: 1) the country increases its ability to have appropriate technology because it is required, and 2) the country can choose the technology required and use it without first establishing a scientific community. Entering the world of modern

industry, with its science and technology, entails entering a new value order based on efficiency, logic, and pragmatism. Information has the power to change the face of the world, and those who control information have the power to control everything: world opinion, politics, society, and economics. Knowing where and how to obtain information, selecting information based on its use for personal development, analyzing data obtained with computer technology, and synthesizing the results of the analysis so that they can formulate excellent and correct decision alternatives, make decisions, and develop the knowledge that has been obtained are all skills required to master technology [28].

On-Board Diagnostic (OBD) is a computer-based system designed by automakers to diagnose vehicles. It focuses on diagnosing car engine performance to detect flaws in car engine components [17][33][34]. OBD-II was first introduced in the mid-90s, where in previous use, OBD served as a solution to the problem of vehicle exhaust emissions and fuel usage to make it more efficient. Then in 1996, OBD II first appeared, where the function was even more sophisticated, namely being able to read information from the car ECU and monitor several parameters.

One of which was that the device on the car, body, chassis, and OBD-II now connect to the internet network using 4G or Wi-Fi. The way OBD-II works is that the sensor will read the ECU with different parameters, which include battery status, temperature, fuel level, RPM, time since the engine started, and total engine operation in hours. Several parameters will be read directly from the vehicle, and the incoming data will be processed for processing and will monitor sensors and other parameters; well after that, the incoming data will be stored in memory [35].
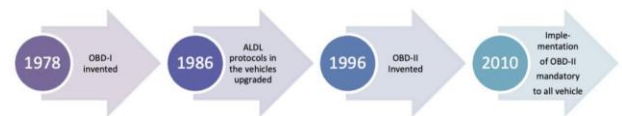

Figure 1. OBD-II technology

The Engine Control Unit (ECU) is an essential part of the vehicle's engine control system formed by a microprocessor for hardware consisting of several sensors and software controls to manage sensors on the vehicle. The function of the ECU is to receive data and engine status signals and then actuate the actuator circuit to achieve its control objective. To be able to communicate with OBD-II, a specific compatible protocol is required so that the communication process between the ECU and OBD-II can run. For example, the protocol is CAN, SAE J1850 PWM, SAE J1850 VWM, ISO 9141-2, ISO14230-4 (CAN), and other protocols [36].

Visual media, in practice, has a significant role. Vehicle diagnosis is one of the competencies for automotive engineering teacher candidates. Teaching aids are part of learning media. The term media needs to be understood first before discussing further

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teaching aids. Learning media is defined as all objects as aids in the learning process.

It was becoming an intermediary for the learning process both inside and outside the classroom. Based on its function, learning media can be teaching aids and learning tools. From the descriptions above, the notion of educational aids is anything that can be used to stimulate students' thoughts, feelings, attention, skills, and willingness so that they can encourage the learning process. on students. There needs to be more than the existing visual media for diagnosing vehicles that already have an OBD (On Board Diagnostic) II system. This study aims to analyze the learning media's needs for making wireless engine diagnostic tools with raspberry pi.

RESEARCH METHOD

This research is research and development with the ADDIE model. The ADDIE model is suitable for developing learning media which consists of the analysis, design, development, implementation, and evaluation stages. The ADDIE model diagram can be seen in the image below.
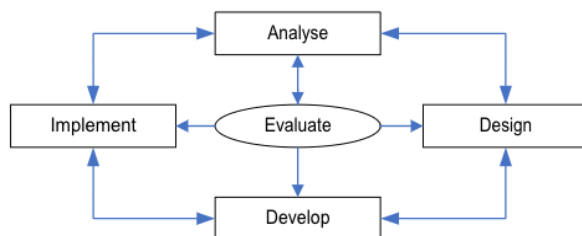

Figure 2. ADDIE design [37]

The application of ADDIE to instructional systems design facilitates the complexities of intentional learning environments by responding to multiple situations, interactions within context, and interactions between contexts [37]. The research sample is in the form of an application layout design that will be developed. The instrument in this study was an assessment sheet in the form of a questionnaire regarding the feasibility of the design. Experts in the field of application development assess designs. The feasibility test is used to determine the feasibility level of the product being developed to see whether the product can be implemented. The feasibility level of the developed product is measured using the following analytical techniques:

$$p = \frac{\Sigma n}{\Sigma N} \times 100\%$$

Information:

Q: Percentage of eligibility assessment

Σn: Total score of assessment aspects obtained from experts

ΣN: Sum of the maximum scoring scores (maximum value of each item x number of question items x number of respondents)

The following table shows the percentage of the feasibility of learning media that has been developed:

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Table 1. Learning media eligibility criteria

Percentage	Interpretation
81-100%	Very Decent
61-80%	Decent
41-60%	Decent Enough
21-40%	Less Eligible
0-20%	Not Eligible

Learning media is feasible if a minimum percentage is included in the decent enough category.

RESULT AND DISCUSSION

This research only reached the design stage. The analysis stage is to determine the needs in the development process. The design phase is carried out based on the study's results in the previous step. Next, arrange an implementation schedule and material plans to be included in the learning media. The research begins with an analysis phase in the learning process. Prospective vocational education teachers do practical work to gain skills that will be taught in vocational schools later. Vehicle diagnostic material is one of the essential lessons to determine the damage to the vehicle's Fuel Injection system. A complex system makes the material require practical media that can help students learn.

Needs analysis is carried out in observation to find gaps in learning vehicle diagnosis. A competency gap was found for prospective vocational teacher students who

showed results below those expected in online learning in the vehicle diagnostic practice course. This gap indicates that during learning during the Covid-19 period, students only discussed the diagnosis of fuel injection-based vehicles, which differed from actual practical activities. In contrast, the front-end analysis involves analyzing the technology used in the vehicle diagnosis process.
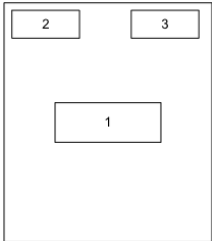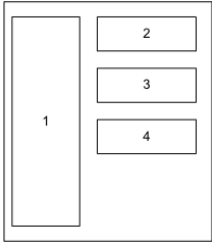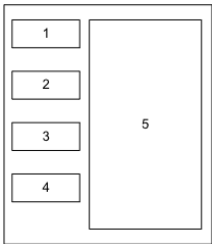
The vehicle diagnostic equipment owned by the laboratory is limited in number and expensive. This means that a vehicle diagnostic tool can be developed to support the practical learning process. Student analysis includes learning characteristics and student conditions. This situation analysis shows that during the Covid-19 pandemic learning to diagnose vehicles was carried out online, which resulted in a lack of practical experience in diagnosing fuel injection-based vehicles. The limitations of a fuel injection-based vehicle diagnostic device owned by the lab require using vehicle diagnostic tools interchangeably. This causes the learning process to run less effectively.
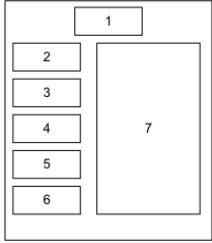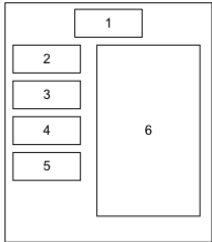
Analysis of current issues after the Covid-19 pandemic requires educators to be more creative in making learning media according to their needs [12][38][39][40]. Innovations were made in developing this media by utilizing the Raspberry Pi as a processing medium and presenting data for diagnosing fuel injection-based vehicles. The analysis aims to identify the targets to be achieved in learning vehicle diagnosis, where students

must understand the signs of fuel injection-based vehicle damage. Cost analysis is the development of a vehicle diagnostic tool. Data analysis was done by identifying vehicle manual books, worksheets, modules, and vehicle diagnostic teaching materials.

Based on the description above, the development of the Wireless Engine Diagnostic Tool with Raspberry Pi for Learning Media Vocational. The design phase is carried out through content planning, including application design, material design, and device connectivity design with the ELM327. The first result contains the results of the application design analysis carried out by making a storyboard, as presented in table 2 below.

Table 2. Storyboard wireless engine diagnostic tool

No	Interface	Explanation
1		"Home" 1. Start 2. University Logo 3. Ministry of Education Logo
2		"Main Menu" 1. Main Menu 2. Connect Button 3. Diagnostic Button 4. General Information
3		"Sliding Menu" 1. Dashboard 2. General Information 3. Diagnostic Trouble Code 4. Settings
4		"Sensor Information" 1. IAT Sensor 2. ECT Sensor 3. MAP Sensor 4. Battery Voltage 5. Fuel System 6. Control Module Voltage
5		"DTC Status" 1. MIL Status 2. Voltage Level 3. Error Count 4. Error Codes

Design plans are made on each storyboard to get the appropriate appearance. Number 1 shows the storyboard design on the "Home" view. The initial display shows an identity consisting of the university and ministry logos. Also added a start button to start the app.

Number 2 shows the main menu display. There are several menu options on the main menu, such as connect button, diagnostic button, and general information. The proportion of the area is balanced to meet the display on the application. Number 3 shows the storyboard on the sliding menu. The sliding menu contains the dashboard, general information, diagnostic trouble code, and settings. Number 4 contains sensor information that has been detected, such as IAT, ECT, MAP, Battery Voltage, Fuel System, and Control Module Voltage. Number 5 shows the storyboard on DTC Status. DTC status is information on the diagnostic system on the EFI system through information on the sensor.

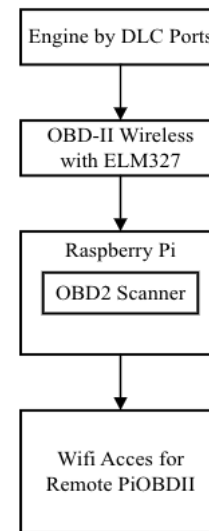DTC status contains MIL, Voltage, and error codes on the system.

Furthermore, the results of the assessment by experts are in the table 3 below.

Table 3. The expertise score

No	The Expertise	Score
1	Expertise 1	112
2	Expertise 2	114
3	Expertise 3	109
	Total	335
	Maximum Score	375
	Percentage (%)	**89,33%**
	Category	**Very Decent**

Based on the calculation results in table 3 above, it can be concluded that the results of the media feasibility test by media experts obtained a total score of 335 out of a maximum score of 375 with a percentage of 89.33% or can be categorized as "very feasible" to continue at the development stage. The design of device connectivity mechanisms by students involves several devices. The connectivity scheme is shown in the following figure.

The design of wireless engine diagnostic learning media is used to scan vehicle devices to determine engine conditions. The engine uses a fuel injection system that has access to ECU (Electronic Control Unit) data. This learning media helps students to diagnose damage symptoms more quickly. This learning media was designed based on the needs and devices available in the automotive workshop.

Figure 3. Learning media flow

CONCLUSION

The design of learning media Design of the Wireless Engine Diagnostic Tool with Raspberry Pi can be developed for practical learning of vocational students. The design of this learning media is in the form of a storyboard display and workflow. Furthermore, research is carried out in the development and implementation stages.

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