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Learning Effectiveness Using Emsob in Enhanching Automotive Electrical Problems Solving Skills

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Abstract:

One of the indicators for passing automotive training participants is the ability to solve automotive electrical problems. However, in reality, some of the participants in the automotive training center don't have such abilities. Engine Management System On Board (EMSOB) helped trainees to master skills in solving automotive electrical problems. The purpose of this study is to assess the effectiveness of EMSOB in improving skills in solving automotive electrical problems. This research employed a quasi-experimental non-equivalent pretest-posttest design, with a total sample of 42 automotive training participants at the State University of Malang. Research data were collected using tests, observations, and interviews. The data analysis technique used in this research was the Anova test. The research findings showed that the experimental class had better skills in solving automotive electrical problems than did the control class. This media has advantages including: being able to show the components of EPI, being able to display automotive electrical diagrams, making it easier to simulate electrical damage to EPI, and making it easier to perform a breakdown analysis. This media is equipped with modules, worksheets, and manuals, so that it has an impact on the effectiveness of EMSOB.

Keywords: engine management system on board, problem-solving, automotive training, automotive electric

EFEKTIVITAS PEMBELAJARAN MENGGUNAKAN EMSOB DALAM MENINGKATKAN KEMAMPUAN *PROBLEM SOLVING* KELISTRIKAN OTOMOTIF

Abstrak: Salah satu indikator kelulusan peserta pelatihan otomotif adalah menguasai kemampuan problem solving kelistrikan otomotif, namun kenyataan yang terjadi di tempat pelatihan otomotif beberapa peserta tidak menguasai kemampuan itu. Engine Management System On Board (EMSOB) yang berbasis simulasi membantu peserta pelatihan untuk menguasai problem solving kelistrikan otomotif. Tujuan penelitian ini untuk mengidentifikasi efektivitas EMSOB dalam meningkatkan kemampuan problem solving kelistrikan otomotif. Jenis penelitian ini adalah quasi eksperimen non equivalent pretest-posttest, dengan jumlah sampel sebanyak 42 peserta pelatihan otomotif di Universitas Negeri Malang. Data penelitian dikumpulkan menggunakan tes, observasi, dan wawancara. Teknik analisis data menggunakan uji Anova. Temuan penelitian menunjukkan bahwa kelas eksperimen memiliki kemampuan problem solving kelistrikan otomotif lebih baik dari kelas kontrol. Media ini memiliki keunggulan meliputi: dapat memperlihatkan komponen-komponen sistem kontrol mesin bensin injeksi, dapat menampilkan diagram kelistrikan otomotif, memudahkan melakukan simulasi kerusakan kelistrikan kontrol mesin injeksi, dan memudahkan melakukan analisis kerusakan. Media ini dilengkapi dengan modul, jobsheet, dan buku manual, sehingga berdampak pada efektivitas EMSOB.

Keywords: engine management system on board, problem solving, pelatihan otomotif, kelistrikan otomotif.

INTRODUCTION

The work in automotive repair shops can be classified into periodic maintenance and repairs in which to complete the work needs a competent technician. Every day, there is a need for automotive technicians. The provision of automotive education and training can help meet the need for competent technicians. Competent technicians get their abilities through the right learning process. One of the learning methods applied in automotive training is problem-based learning. This lesson is useful for teaching problem-solving skills that are useful for trainees when working for a car repair shop.

Automotive training graduates will work for automotive repair shops. They are expected to be able to do problem-solving work (Klegeris et al., 2017). Problem solving is an ability that must be possessed by the workforce (Schleicher, 2012; Zamri, 2016). Problem solving is an ability that must be mastered by automotive training graduates in the industrial era 4.0. Problem solving, communication, and collaboration skills are skills that must be mastered by future workforce (Jabarullah & Iqbal Hussain, 2019). It is important to improve the problem-solving skills of trainees, so that their future is guaranteed (Eichmann et al., 2020).

Based on observations and interviews with instructors in automotive training, it was found that automotive training participants did not master the skills in solving electrical problems, because it still used conventional learning methods and employed no media when delivering their subject material. This was in line with the research of Rahmazatullaili et al (2017) which states that the trainees in automotive training have low problem-solving skills.

Efforts to improve problem-solving skills can be made through education or training activities by applying problem-based learning, and on-the-job training in order to gain meaningful experience. Problem-based learning is effective for improving problem-solving skills (Jabarullah & Iqbal Hussain, 2019). This learning can produce skills with better retention in the long term, and can develop critical-thinking skills. Problem-solving skills can also be improved by using media to make it easier to convey material. Media-based learning provides advantages in learning (Manurung & Panggabean, 2020). Learning using media can improve problem-solving skills (Akcaoglu, 2014). Meanwhile, Barak & Assal (2018) used the P3 model (practice, problem-solving, and project) in robotic learning. The results of this research showed an increase in problem-solving skills. Another way that can be taken to improve problem solving skills is to apply problem-based learning with the Realistic Mathematics Education (RME) method which consists of 3 stages: the preliminary phase, the prototyping phase, and the assessment phase (Eliza et al., 2018). There are many methods that can be applied to improve problem-solving skills, like what was done by Kothiyal & Murthy (2018) by using the Technology Enhanced Learning Environment (TELE) to improve the problem-solving skills of engineering students who have graduated from colleges Similarly, Cai et al (2016) applied multitasking collaborative learning and Tawfik et al (2014) applied the Case Libraries model. Both studies resulted in an increase in problem-solving skills.

Previous researchers used several methods to improve problem-solving skills. However, learning skills at problem solving requires the right media and should be in accordance with the learning objectives. Therefore, this study used EMSOB which is a learning tool equipped with modules, manual books, and worksheets. This media has advantages, one of which is to show Electronic Petroleum Injection (EPI) components, electrical diagrams, the ease of simulating EPI electrical damage, and steps in resolving the damage. The purpose of this study was to identify the effectiveness of problem-based EMSOB in improving problem-solving skills.

METHOD

This research employed the quasi-experimental, non-equivalent pretest-posttest design (Nasrullah, 2019), involving participants of the automotive training at the State University of Malang (PUSDIKLAT SUZUKI-UM). The population and sample in the study were 42 participants who had attended the training for 6 months. The population and sample were then divided into 2 classes, namely the experimental class and the control class.

The indicators of participants’ problem-solving skills include their knowledge of mentioning the name of the component, explaining the function of the component, explaining the work of the system and explaining the procedure for solving the Electronic Petroleum Injection electrical problem which consist of measuring the sensor-connector voltage, measuring sensor resistance, and measuring the sensor cable connection to the ECM. Beforehand, the indicators were put to a test to ensure their validity and reliability.

Research data were collected using tests, observations, and interviews. The written test was given in two stages, namely a pretest and a posttest. The results of the written test were put to another test for to normality, then analyzed using Anova. Observations were made to determine the practice process. Interviews were conducted at the end of the implementation using the posttest results as an indicator for selecting informants. The interview involved two informants are participants who got good grades and participants who did not experience any changes after being given treatment. The questions asked to the informants were the material tested on the written test, the experience after using EMSOB, and general information about the material on the machine control system while in vocational high schools.

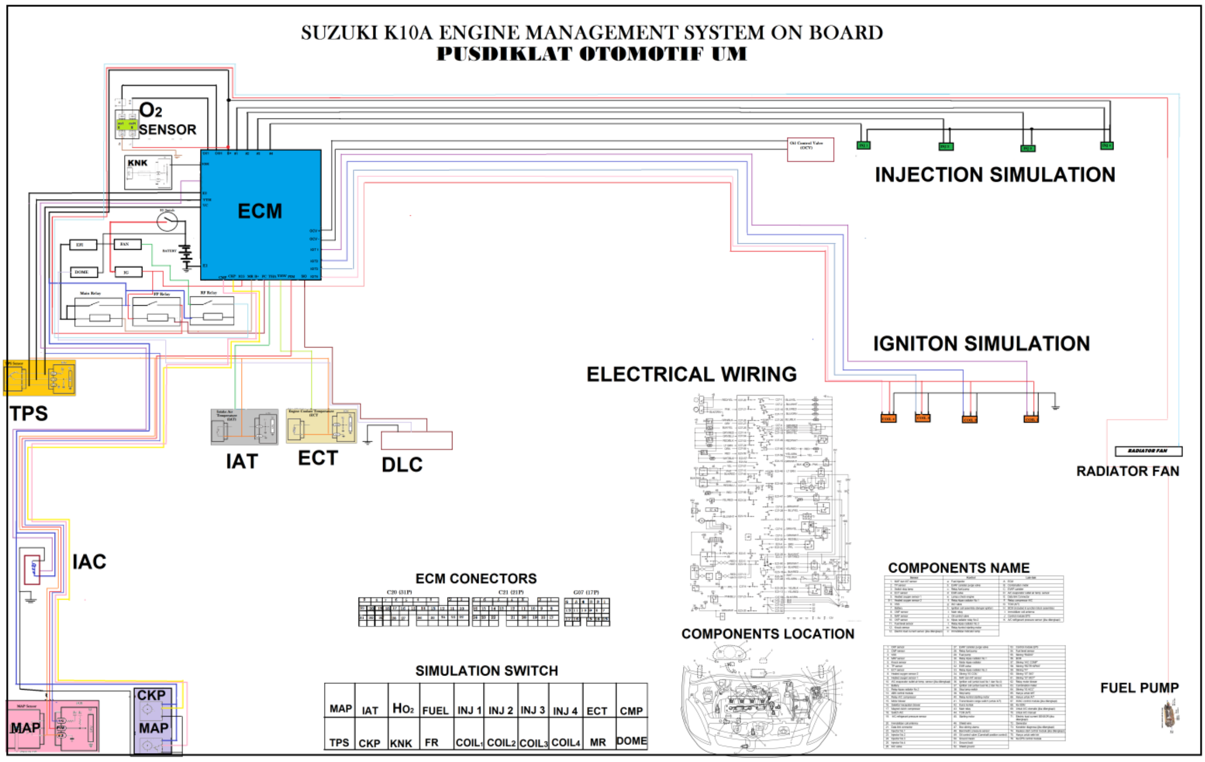

Figure 1. Layout of EMSOB Media

The EMSOB media in Figure 1 has several components are sensors that function as signal inputs for the ECM, actuators that function as an input receiver from the ECU, the scan tool to read fault codes and control system data, a computer to store supporting data in the form of manuals and books, fault simulation control, and voltmeter to measure voltage and resistance.

This study used EMSOB in the experimental class and Engine Stand (ES) in the control class. Implementation of the experimental class and control class begins with giving a pretest. The pretest-posttest indicators are component names, component functions, and the procedures of the system problem-solving steps. The next step was the delivery of materials such as pretest indicators. The teacher in the experimental class conveyed the material using EMSOB to sreamline the process of finding the components of the EPI, while in the control class the teacher used power points. Ease of identifying component names helped trainees to remember. The next step was to present the material on the function of the EPI components by illustrating them in EMSOB and displaying ECU data using the scan tool. The next step was delivering material on how the EPI works. The material was delivered using EMSOB to describe the relationship between the sensor and the Engine Control Module (ECM). This activity could not be carried out in the control class because it was not possible to bring the engine stand to the theory class. EMSOB can display the components and electrical diagrams of the EPI on a flat surface, thereby allowing teachers to easily convey the relationship between the sensor and the ECM.

The last material on implementation in the experimental class and control class is the material on solving the EPI problem, including measuring the voltage of the sensor connector, testing sensor performance, and measuring the resistance of the cable between the sensor and the ECM. This media has the advantage of making easy the process of taking problem-solving steps. The teacher plays a video about EPI that has been provided by the researcher on a YouTube channel. Researchers made observations during the process of delivering material. At the end of the delivery of the material, a posttest is given whose indicators asked were the same as the ones in the pretest. The results of the pretest and posttest were then tested for normality followed by the ANOVA test. The results of the analysis were then used as the basis for selecting interview informants. Interview indicators included posttest indicators and several questions about the experience of using EMSOB. The purpose of the interview was to confirm the posttest results by way of ensuring their validity.

The next implementation process was the practice process. The experimental class and control class were divided into 6 groups, 4 groups consisting of 3 people and 2 groups consisting of 4 people. The teacher arranged the course of practical activities so that the trainees did their own practice. The experimental class used EMSOB, while the control class used the engine stand. Worksheets filled out by trainees dealt with identification of EPI components, measurement of sensor connector voltage, measurement of sensor resistance, and measurement of connection between sensor and ECM. During the practice, the researchers made observations. At the end of the practice the teacher gave a practical exam in the form of solving simple problems. The assessment indicators in the practical exam included students' ability to name the components orally and explain the function of each component orally and their results of working on the worksheets. The time required to complete the work was written on each worksheet. The results of the calculation of the time the control class took to complete the work were then compared with the time which the experimental class took to do so.

FINDINGS AND DISCUSSION

Findings

One indicator of the success of automotive training is the mastery of the skill in solving automotive electrical problems. This skill can be developed by giving treatment in the form of using EMSOB. The results of the pretest-posttest control class and experimental class are shown in Table 1

Table 1. Description of Pretest and Posttest Data

	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Mean	42	75	37.70	48
Median	50	75	33	50
Variance	548.28	147.74	299.10	308
Std. Deviation	23.41	12.15	17.29	17.55
Minimum	8	50	8	30
Maximum	75	100	67	92
Success	44%		21,45%	

The average pretest score of the experimental class was 42, and the average score of the process was 75; meanwhile, the median pretest score of the experimental class was 50 and they got he score of 75 for the median process. The minimum pretest value of the experimental class was 8, while their minimum posttest value was 50. The maximum pretest and pretest values of the experimental class were 75 and 100 respectively. Compared to the results in the pretest, the mean and median scores, minimum value, and maximum value in posttest results after being given treatment using EMSOB increased. The average score for pretest of the control class was 37.70, while the average score for the process was 48. The median pretest score of the control class was 33 and the median score for the process was 50. The minimum score for the pretest of the control class was 8, while their minimum score for the posttest was 30. The maximum score for the pretest of the control class was 67, and their maximum score for the posttest was 100. The success in using EMSOB to improve problem-solving skills accounted for 44%, while the success in using Engine Stand amouted to 21.45%. There was an increase in the mean and median scores, minimum values, and maximum values after the giving of the treatment using the Engine Stand (ES). Overall, the experimental class had a better posttest score than the control class. This meant that EMSOB is effective for improving problem-solving skills. The result of the ANOVA analysis of post-test result of the control class and the experimental class showed a significance level of 0.00. This meant that there was a difference in problem-solving skills between the control class and the experimental class.

The comparison between the use of the engine stand and EMSOB in relation to the time for worksheet completion was depicted in Table 2. On average, those using the engine stand took 80.24 minutes to complete the worksheet, while those using EMBOS took 60.67 minutes to do so. The fastest time clocked up by those using the engine stand to complete the worksheet was 58 minutes, while the fastest time clocked up by those using EMSOB was 40 minutes. The median time of the control class was 80 minutes, while that of the experimental class was 60 minutes. This means that EMSOB is efficient to speed up he process of filling out worksheets.

Table 2. Worksheet Completion Time

	Experimental Class (minutes)	EMSOB Control Class (minutes)
Mean	80.24	60.67
Minimum	58	40
Maximum	95	80
Range	37	40
Median	80	60

Discussion

EMSOB can improve the problem-solving skills of automotive trainees. As shown in Table 1, there is a difference in the improvement of problem-solving skills between the experimental class and the control class. The engine stand used by the control class had a limited ability to display its components. The control class trainees had to identify the location of the components, while the control class trainees who use EMSOB found it easier to find the components. This media is very suitable for training participants who come from public schools or madrasas who do not get automotive material.

Automotive training participants as prospective car technicians must have the skill to repair automotive electrical problems. This skill is formed from the ability to name electrical components. Misunderstanding the name and location of the components caused the trainees to make mistakes in checking those components. The observation results showed that the experimental class trainees could easily identify the names of the EPI components. The ability to identify components was a minimum competency to be mastered by training participants in order to be able to solve problems. Teachers in the experimental class easily demonstrated the components of EPI so that the knowledge transfer process worked more seamlessly. Learning using EMSOB gives teachers a greater opportunity to deliver a variety of materials. Multitasking learning can improve problem-solving skills (Atmatzidou et al., 2018). Researchers prepared EPI learning videos on a YouTube channel aimed at making it easier for training participants to access information via cellphones and study independently. This research was supported by Banerjee et al (2015) which states that by using media, higher cognitive skills can be acquired and problem-solving skills can be improved. Learning using information technology such as mobile phones has an influence on the achievement of learning objectives (Arifin et al., 2021).

Experimental class trainees had advantages. The minimum value of the experimental class was higher than the control class. Based on the results of interviews, after practicing at EMSOB, training participants could name the components of the EPI. The ability to name components is a prerequisite for conducting component inspections. Continuity of competence is the main concern in this research. EMSOB made it easier for trainees to identify where the EPI components were located. Identifying the component names was seen as one indicator. The experimental class participants could directly point out the components and read their functions, while the control class had to look for those components before doing so. Media that provide comprehensive instructions can ensure the achievement of learning objectives (Akinsola, 2014). Likewise, Ryan et al (2016) stated that there is a strong relationship between the media and the ability to understand problem-solving instructions.

The Engine Management System (EMS) is the most important part of the Electronic Fuel Injection system (Lahti, 2014). This system is generally installed in the vehicle, and in this study it was installed on a flat plane called EMSOB. This media becomes an intermediary in delivering EPI material. The purpose of making EMSOB is to make it easier for teachers to name components, explain component functions by directly illustrating them on the components described, and demonstrate problem-solving steps directly on EMSOB. Giving good demonstrations is instrumental in improving problem-solving skills (Saw, 2017; Retnowati, 2018).

The first step in solving the EPI electrical problem is to check the voltage of the EPI component connectors. The purpose of this step is to ensure that the sensor voltage coming from the ECM is up to standard. Voltage standards can be found in the manual provided on the EMSOB computer. This step is the first competency that must be mastered by trainees when solving problems. Based on the observations of the experimental class trainees, they could directly measure the sensor and actuator voltages because the point for measuring voltages is already available without removing the connector. The control class participants first removed the sensor and actuator connectors to measure the voltage. The job of removing the connector can damage the cable if the wrong method is used. One of the goals of making EMSOB is to avoid component damage due to frequent removal.

The results of the step-by-step inspection of sensor and actuator voltages can be used to conclude the condition of the cables and the Engine Control Module (ECM). If the voltage measurement results are in accordance with the standard, it can be concluded that the cable and ECM are not problematic. Researchers designed EMSOB with the aim of making it easier to work on the EPI system worksheet, so that there are more opportunities to repeat the work. The results of the practicum in Table 2 show that it takes less time for the experimental class trainees to complete the worksheets than the control class trainees. In this study, the speed of solving problems was regarded as one aspect of the assessment. The number of repetitions will affect the ability that can be mastered. The faster the completion of the worksheet, the more time is left, thereby allowing the work to be redone. Some trainees who did not complete the final exam were given the opportunity to repeat the practice, so that they could complete the work on time. Based on the information obtained through interviews, not all of the trainees had ever taken sensor voltage measurements. Each trainee worked on the worksheet according to their abilities, so they might have followed a different sequence of actions. Learning using EMS media is effective for improving problem-solving skills (Marji, 2020; Komarudin, 2020).

Based on observations during practice, most of the trainees were able to carry out tension checks. The results of the observations were confirmed by the data in Table 1 which shows that there is a difference in the maximum value between the control class and the experimental class. Computer-based media have an influence on knowledge and problem-solving skills (Manurung & Mihardi, 2018; Melander Bowden, 2019; Sazali et al., 2016; Tudor, 2016).

The second step in solving EPI problems is to measure the component resistance level. The damage control of EPI electrical components can be aken by measuring their resistance level. Each automotive electrical component has different characteristics, which are described in the service manual. EMSOB is equipped with a manual book that is stored on the computer. The trainees measured resistance using a voltmeter. This media made it easier for participants to measure prisoners. EMSOB is equipped with a terminal to measure resistance, while on the engine stand to take resistance measurements you have to disconnect the connector. This media provides a greater possibility of learning success than an engine stand as shown in Table 1.

The third step in solving the EPI problem is to check the resistance of the cable connecting the ECM to the sensor. The main prerequisite for mastering the competence to measure cable resistance is the ability to use an automotive multi tester. Automotive training participants came from schools with different standards, so their ability to use measuring tools also varied. At the beginning of the study, the researcher demonstrated all the problem-solving steps using a multi tester at EMSOB. Given that measuring cable resistance is an important competency in troubleshooting, an error in measuring cable connections can lead to wrong conclusions. Additionally, training participants are expected to improve their thinking skills and problem-solving skills after using EMSOB, because problem-solving work is an activity requiring a high level of thinking skills. Learning to use media also affects problem-solving skills (Karagozlu & Ozdamli, 2017). Trainees who have the ability to analyze cable resistance will benefit from solving problems. The ability to perform a cable connection check in a car or on an engine stand is a difficult job to do because the sensor connectors and the ECM are far from each other and it is difficult to find cables to check. The trainees in the experimental class measured the cable connections at the terminals that have been provided, so the job took them a shorter time to take the measurement. This media made it easier for participants to do this work, because the media was equipped with EPI electrical wiring. This research basically aimed to form a thinking map in solving problems using EMSOB.

The use of EMSOB based on problem solving offer several points of advantages of easing participants' process of identifying components' names and locations, undersanding the functions and workings of the engine control system, and checking connector voltages, the connection among cables, and electrical components. Those advantages will in turn help ease training participants' process of forming a map of solving electrical problems of EPIs.

CONCLUSION

EMSOB is designed to improve the electrical problem-solving skills of automotive trainees. The media can be applied to automotive training centers. The effort o maximize the use of EMSOB must take several things into consideration are the worksheet used must be detailed and adapted to the needs, the module used should be based on the EMSOB, and the teacher who conveys it must understand the EPI material. The use of this media will help participants to acquaire technical competencies in naming the components of the EPI, explaining the function of the components, explaining how the system works, and softly finishing solving EPI electrical problems. The problem-solving steps include measuring the voltage of the sensor and actuator connectors, measuring the resistance of the sensor or actuator, and measuring the resistance of the cable connecting the sensor to the ECM. The success rate of the use of EMSOB and ES to improve the skills in solving EPI problems is 44% and hat 21.45% respectively. Additionally, EMSOB is efficient for completing EPI worksheets during practical activities.

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