Efforts to improve chassis system learning through learning media anti-lock brake system (ABS) integrated hardware-in-the-loop (HIL)

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Abstract. The chassis system directs students to understand the basic concepts of modern motor vehicle maintenance and repair. One of the subjects is the anti-lock brake system (ABS) which can cause misconceptions in learners. So it takes learning media that can improve understanding and learning results, namely learning media anti-lock brake system (ABS) integrated hardware-in-the-loop (HIL). The implementation of ABS-HIL aims to improve student learning outcomes. Before application, the development of learning media is carried out. Sample of 27 students, with observation & pre-test & post-test data collection techniques. The data is analyzed descriptively and tests "t". The results of the study found an improvement in the results of the study proven post-test scores = 90.44 more than the pre-test score = 78.44.

1. Introduction

In teaching and learning activities, students are expected to receive the knowledge that has been conveyed by educators. The identification that students have received knowledge and understood it can be seen from the results of the study. In the delivery of a material it would be better to use a learning medium as an intermediary directly associated with real life, especially when it comes to engineering. Of course, the use of learning media is highly recommended in the delivery of a material by educators, in the hope that students can receive and absorb the knowledge provided by educators to the maximum. In addition, it is also expected that with the use of media trainers can improve the quality of a learning process.

Higher education in this case Universitas Negeri Malang, especially Automotive Engineering Education is an institution tasked with organizing teaching learning activities that have a vision to produce qualified graduates and ready to compete in the era of globalization as it is today. Many efforts have been made to improve the quality of learning outcomes, one of his efforts is to develop learning media for the course of chassis system.

The chassis system course is one of the courses that must be mastered by every graduate, therefore the achievement of learning results in this course must be maximized, and hopefully graduates are able to understand and practice the science of this chassis system in real life.
chassis system is part of the system located in a vehicle. In the chassis system, there is an ABS system. Abs or also known as Anti Lock Braking System is a brake system that exists in car or motorcycle vehicles so as not to occur wheel locking when the rider suddenly recedes (WABCO, 2011; Wibowo, 2011; Indra, 2013; Mende, et al, 2008; Rakhman, 2012). Because of the complexity circuit in the system, as well as the control system that exists in the system, requires sufficient understanding through learning media. This is supported by evidence of learning students who program the chassis system course 1 year ago is not good, with 5.26% getting an A grade, 10.5% getting an A-grade, 47.36% getting a B+ grade, 21% getting a B grade, 10.5% getting a B-grade, and 5.26% getting a D grade.

Based on the background of the above problems, how to improve the learning outcomes of students who program chassis system courses through learning media anti-lock brake system (ABS) integrated hardware-in-the-loop (HIL). Hil's integrated intent and purpose is that ABS sensors leading to the ECU can be manipulated and sent from a computer. Through the PCI-CARD component as a converter, connect and translate the regulated sensor performance from the computer to the ABS actuator. So hopefully learners can set abs sensor input, study and diagnose ABS system through computer summarized into one learning media namely ABS-HIL. While the scantool can only see abs damage diagnoses, it cannot provide ABS sensor input with diverse vehicle conditions.

The goal that this study wants to achieve is to improve student learning outcomes, while proving that ABS-HIL media learning can benefit chassis system lectures at The Automotive Engineering Education of Malang State University in particular, and other higher education that organizes the same courses.

![Figure 1. ABS-HIL Test Bench Products](image)

2. Method
Efforts to improve student learning outcomes in chassis system courses are carried out through a kuantitatif-demonstration approach using ABS-HIL media learning. Instruments used are 1) ABS-HIL learning media, 2) pre-test & post-test instruments. The population of this study is a
5th semester student of the Bachelor's degree in Automotive Engineering Education of Malang State University. The sample from this study was taken by 1 class of 27 students using cluster sampling techniques. The data collection techniques used in this study are 1) observations (observations), and 2) pre-test & post-test. The data analysis technique used is descriptive analysis for observation results and t test two interconnected samples for pre-test & post-test.

3. Result and discussion

ABS-HIL media learning is applied to chassis system lectures with demonstration methods. To see the improvement in student learning outcomes, abs subject pre-test & post-test. Pre-test & post-test results are analyzed using t test two samples interconnected with the following steps:

3.1. Formulating hypotheses:

H₀ : There is no difference in student learning outcomes before and after studying ABS material through ABS-HIL learning media

Hₐ : There are differences in student learning outcomes before and after studying ABS materials through ABS-HIL learning media

3.2. Create a data description matrix support t test:

Table 1. Data Description Matrix Supports T Test

| No. Resp. | Score | D = (X-Y) | D²(X − Y)² |
|-----------|-------|-----------|-------------|
|           | Post-test (X) | Pre-test (Y) |             |
| 1         | 84     | 78        | 6           | 36          |
| 2         | 88     | 82        | 6           | 36          |
| 3         | 90     | 78        | 12          | 144         |
| 4         | 90     | 78        | 12          | 144         |
| 5         | 90     | 82        | 8           | 64          |
| 6         | 92     | 76        | 16          | 256         |
| 7         | 92     | 72        | 20          | 400         |
| 8         | 94     | 72        | 22          | 484         |
| 9         | 94     | 76        | 18          | 324         |
| 10        | 96     | 86        | 10          | 100         |
| 11        | 96     | 86        | 10          | 100         |
| 12        | 94     | 76        | 18          | 324         |
| 13        | 94     | 72        | 22          | 484         |
| 14        | 92     | 72        | 20          | 400         |
| 15        | 92     | 76        | 16          | 256         |
| 16        | 90     | 82        | 8           | 64          |
| 17        | 90     | 78        | 12          | 144         |
| 18        | 90     | 78        | 12          | 144         |
| 19        | 88     | 82        | 6           | 36          |
| 20        | 84     | 78        | 6           | 36          |
| 21        | 84     | 78        | 6           | 36          |
| 22        | 88     | 82        | 6           | 36          |
| 23        | 90     | 78        | 12          | 144         |
| 24        | 90     | 78        | 12          | 144         |
3.3. Calculate observations with the following steps:

a. Find Mean of difference = M_D:

\[ M_D = \frac{\sum D}{N} = \frac{324}{27} = 12 \]

b. Find Standard Deviations (SD_D):

\[ SD_D = \sqrt{\frac{\sum D^2}{N} - \left(\frac{\sum D}{n}\right)^2} = SD_D = \sqrt{\frac{4608}{27} - \left(\frac{324}{27}\right)^2} = \sqrt{170.67 - 144} = \sqrt{26.67} = 5.16 \]

c. Find Standard error from mean of different = (SE_MD):

\[ SE_MD = \frac{SD_D}{\sqrt{N-1}} = \frac{5.16}{\sqrt{27-1}} = \frac{5.16}{5.10} = 1.01 \]

d. Calculating Results t observation with statistical formula:

\[ t_o = \frac{M_D}{SE_MD} = \frac{12}{1.01} = 11.88 \]

e. Interpretation and conclusion:

From the calculation result \( t_o = 11.88 \) and when consulted with the table value "t" at the level of significance 5% and df = N – 1 = 27 – 1 = 26 at the level of significance 5% \( t_{table} = 1.7070 \). This indicates \( t \) observation = 11.88 > 1.7070 = \( t_{table} \). So it can be interpreted, accept the alternative hypothesis (\( H_a \)) and reject the zero hypothesis (\( H_0 \)) which means that there are differences in student learning outcomes before and after studying ABS material through ABS-HIL learning media, and those differences are quite significant. So it can be concluded that the application of ABS-HIL learning media is effective to improve student learning outcomes in the chassis system course. Improved learning outcomes can be seen from the comparison of post-test and pre-test scores. In Table 1, post-test scores = 90.44 more than pre-test scores = ...
78, 44,44 so it can be concluded that there is an improvement in student learning outcomes in the chassis system courses through ABS-HIL learning media.

3.4. Discussion
Based on the data of the research presented above shows that the study chassis system assisted by ABS-HIL learning media can improve student learning outcomes. The results of this study are in line with the opinions of several researchers who examined the effectiveness of learning media in learning, such as: Anggereni (2016) concluded that learning media can improve understanding of student concepts. In principle, learning media can build conditions that allow students to acquire knowledge, skills, or attitudes (Gerlach & Ely, 1971). The condition is strengthened by communication, in which learning media serves as a medium or intermediary between educators and learners (Heinich, et al, 1993). As an intermediary, learning media carries messages or information used for learning (AECT, 1977). It is on this basis that learning media effectively provides more understanding to students, because as an intermediary that brings a lot of practical information.

The effectiveness of learning media in improving student learning outcomes in the subject matter chassis system abs is not separated from some elements. The first element is that constructive media learning can make student learning activities effective (Sari & Susanti, 2016). Learning media should be tested to see the effectiveness of learning media in the implementation phase. One of the easiest benchmarks is whether there is an increase in students' learning outcomes, in addition to other benchmarks such as learning activities/processes, evidence of learning such as tasks and homework. Researchers who used learning media to improve the study results of the average learner concluded that the study results using learning media were higher, such as research by Mardhiah & Akbar (2018).

The second element is that ABS-HIL learning media is interactive. As previously researchers have said about how interactive learning media (Maria, et al, 2019) can be meaningful and useful for students. Interactive learning media can make it easier for students to remember content because visualization is clearer, interactive learning media provides new variations in learning for students, and interactive learning media helps to construct students' learning and learning activities.

4. Conclusion
From the results and discussions, it is concluded as follows: 1) there are differences in student learning outcomes before and after studying ABS material through ABS-HIL learning media, and the difference is quite meaningful, 2) the application of ABS-HIL learning media is effective to improve student learning outcomes in the chassis system course, and 3) the learning results can be seen from the comparison of post-test and pre-test scores, which is skor post-test = 90,44 more than the pre-test score = 78,44, and 4) there is an improvement in student learning results in the chassis system courses through ABS-HIL learning media. The effectiveness of ABS-HIL as a learning media due to element 1) is constructive, which can make student learning activities effective, and 2) interactive, can be meaningful and useful because the visualization of content is more clear.

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