Development of Digital Learning Simulators to Increase Vocational Students' Prior Knowledge

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Abstract **– Vocational high schools, receive special attention from the government to produce graduates who are skilled and in line with the demands of the 21st century. The COVID-19 pandemic has disrupted the education system, necessitating a shift from offline to online learning methods. This research focuses on developing digital simulator learning (DSL) media to improve the prior or initial knowledge and problem-solving skills of vocational school students in the field of motorcycle engineering and business. The novelty of DSL media is that students not only learn through the reading process but can also see visually through the simulation process, and also simulate troubleshooting on vehicles. This study follows the analysis, design, development, implementation, and evaluation (ADDIE) model. The research results found that smartphone-based DSL media affected increasing competence in initial knowledge of injection systems, while the effectiveness of DSL media was at a medium level.**

Keywords **– Vocational education, digital simulator learning, prior knowledge, interactive learning.**

1. Introduction

Education in Indonesia is of particular concern to the Indonesian government, one of which is vocational high schools (VHS).

Efforts are being made to produce graduates who suit the needs of the 21st century, including providing them with various 21st century skills. The 21st-century competency standards encompass a range of skills and values that are considered essential for success in the modern world. These standards include: (1) The 4C skills, which are critical thinking, creative thinking, collaboration, and communication; presenting key competencies that enable individuals to navigate the challenges of the 21st century. These skills are crucial for problem-solving, innovation, teamwork, and effective communication; (2) ICT literacy is another important aspect of 21st-century competency standard. This includes proficiency in using technology, media, and information resources effectively and responsibly.; (3) The inclusion of spiritual values, such as religious beliefs and spiritual awareness, recognizes the importance of nurturing a sense of purpose, meaning, and ethical values in individuals; and (4) Character building refers to the development of positive attitudes and values in individuals, including the teacher's attitude and a scientific attitude [1], [2].

The 2019 Coronavirus Pandemic (COVID-19) phenomenon is putting pressure on the world of education, one of which is vocational schools [3],[4]. WHO first announced COVID-19, as a pandemic on March 11, 2020 [5], [6]. The pandemic has posed a substantial challenge to the education sector necessitating a shift from traditional offline learning methods to online platforms as a precautionary measure against the spread of COVID-19 [7]. This shift has presented considerable hurdles for the global higher education community [8]. This pandemic presents practical and logistical challenges and concerns for safety, recognizing that students have the potential to spread the virus without symptoms and can contract the virus during training [9], the impact of this change makes vocational school teachers and students experience difficulties because they have to adapt to new habits. This difficulty arises because several subjects are difficult to implement online. There is still no learning media existing that is connected to the material being taught, for example, in engine subjects regarding fuel injection systems on motorbikes.

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A field survey was conducted to analyze the media used in the learning process by taking a sample of 18 VHSs. The results show that when studying PowerPoint (PPT), media theory is the most widely used by teachers, with a percentage of 42%. Then, for teacher practice, more use of trainers as learning media. Meanwhile, for YouTube and simulation media, it is only 8% and 3%, respectively. PowerPoint is the main choice because this media is easy for teachers to use. Teachers can paste images on PPT and share them with students via WhatsApp group or display them on a projector layer.

Meanwhile, for YouTube and simulation media, few teachers use it because teachers have difficulty finding material that is suitable for YouTube and simulation media, so it can be concluded that currently, the majority of vocational school teachers still use PPT media in classroom learning activities. Furthermore, there remains a scarcity of resources such as simulations and video content that are in accordance with the subject matter of the motorcycle business engineering vocational school. The data obtained from the survey shows that learning activities must be carried out offline in class, teachers have difficulty finding material that is appropriate to the subject matter, the majority of the material available is in PPT format, and and most students do not understand what is being studied. When learning is done online because students are less active compared to learning in class. This situation causes students to have difficulty understanding the subject matter, especially the injection system material on motorbikes.

The survey findings are used as a reference for developing learning media that teachers need to teach and can help students be more active and understand lesson material more quickly, especially injection system material. Learning media serves as a resource employed by educators to convey lesson material to students with the aim of helping students understand the lesson material quickly. One of the facilities that can be utilized as a forum for implementing learning media is a smartphone because of the habits during the pandemic, students always use smartphones in their daily activities, as well as vocational teachers. Smartphones are usually used by students to study, play games, and visit social media. Social media usage in education has become prevalent, playing a crucial role in revolutionizing both learning and teaching methodologies [10], [11].

Learning media constitutes a fundamental aspect of the learning journey [12]. Computing-based learning media stands out as a tool to enhance students' preparedness for contemporary media platforms [13]. Multimedia applications have found utility across diverse domains including business, education, entertainment, and other areas of general interest. Particularly within the education sector, multimedia assumes a critical role in enhancing and advancing the learning process [14], [15], [16]. Chernikova [17] also explains that simulation-based learning offers learning with a practical approach, which is possible when there are learning limitations. Apart from that, this learning is considered very effective for developing complex skills. Furthermore, studies [18], [19] specifically define simulation media as "an educational utensil or device with which students can interact physically to imitate real-world," and they emphasize "the necessity of interacting with authentic objects". Simulation media can adapt several aspects of reality by facilitating theoretical learning carried out virtually before students are ready to do the practicum.

The learning media used must be able to improve prior knowledge abilities. In general, the definition of ability is a person's skill or ability to complete or undertake a job [20]. Meanwhile, prior knowledge or previous knowledge is the knowledge that someone already has and can help to understand new material in a lesson [21]. Explaining that prior knowledge typically encompasses all the information an individual possesses before delving into the study of a specific subject. Meanwhile [22] defines prior knowledge as a complex and stratified entity that is intense and incorporate of variance types of knowledge and skills. According to [23] prior knowledge is an understanding that someone already has that is useful for understanding something effectively. Another definition of prior knowledge is knowledge that influences a person's behavior or learning ability.

Referring to this problem, of course, a solution is needed that can help students improve their abilities both in terms of theory and practice. In this case, the proposed remedy involves creating educational materials in the format of digital simulator learning (DSL). This learning media is deemed appropriate to develop because this media is a combination of PPT and simulation media, so when studying fuel injection system material, students will be more easily motivated and active in order to understand the basic knowledge of injection systems. The novelty of DSL media is that students not only learn through the reading process but can also see visually through the simulation process, which is displayed further than that. Students can also simulate troubleshooting on vehicles using this media. This media has a novelty where this media combines PPT media and simulation. Apart from that, this media is equipped with a simulation feature of how the injection system works, an explanation feature of component names, component locations, component materials, component damage codes, and a practice feature for reading damage codes.

2. Methodology

Digital simulator learning (DSL) media was designed to enhance students' existing knowledge and problem-solving skills that enrolled in the Motorcycle Engineering and Business Expertise Program (TBSM) at vocational high schools (VHS). This research follows the development phase of the ADDIE model for creating and evaluating DSL media [24]. The acronym ADDIE represents the five fundamental phases involved in media development, which include analysis, design, development, implementation, and evaluation. During the analysis stage, as much data and statistics as possible is accumulated to serve as material for identifying the competencies or abilities that students need to achieve and the solutions that can be provided to achieve these learning objectives. In this case, it is also important to be careful in removing extraneous information that is not needed so that the analysis can focus more on time and resources that lead to the achievement of learning objectives. The design stage is conducted using the findings from the analysis phase as a foundation. The aim of the design phase is to produce a blueprint for the DSL media being developed. The development phase carried out in this research included Android-based digital simulator learning (DSL) media. Once the learning media is developed, experts conduct a media validation test and an alpha test. The implementation of DSL media occurs in two stages, including prototype and field testing. The evaluation phase of DSL media is evaluated for its ability to increase students' prior knowledge abilities. In the evaluation, the researchers used parametric analysis techniques. For this research, the independent paired t-test was utilized to examine the hypothesis, while the N-Gain score test was employed to assess the effectiveness of the DSL media.

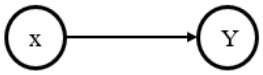


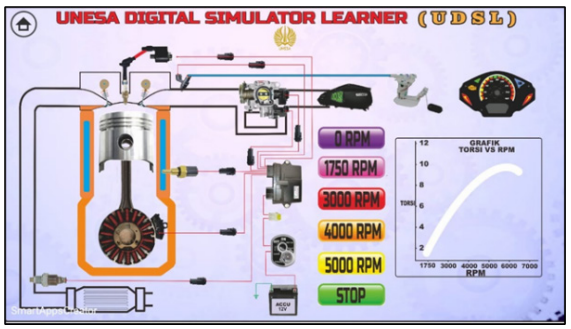
Figure 1. Research design drawings X: Use of DSL media Y: Learning outcomes (initial knowledge of injection systems)

The hypothesis in this research is:
Ha: The utilization of DSL has an impact on student learning outcomes, particularly regarding their initial understanding of injection systems.
Ho: The implementation of DSL does not affect student learning outcomes, specifically in relation to their initial understanding of the injection system.

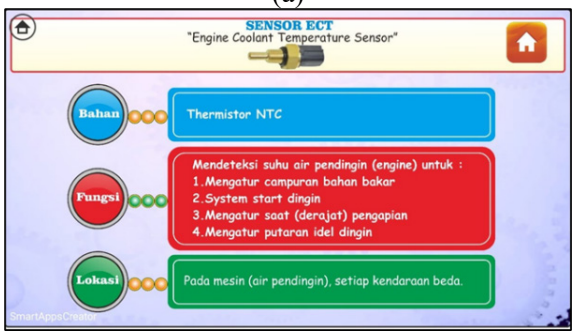
3. Results

The development of digital storytelling language (DSL) media applies the ADDIE concept. In this concept, each phase undergoes evaluation before proceeding to the next phase. Evaluation in each phase is a positive value for this concept. From the results of the analysis, some valuable suggestions were found. Teachers want interactive media that are easy to understand and equipped with guidelines for using the media. Meanwhile, students also provided similar input, namely DSL media should be able to help them accelerate their understanding of the material and be easy to use. It needs to be embedded with games and interactive elements to make this media more interesting. Input from teachers and students has important value as a reference in the development of DSL media. The right media, according to the needs of users (both teachers and students), and able to attract interest, has the potential to increase enthusiasm for learning, which in turn has an impact on student learning outcomes. Garris [25] stated that the game has the potential to help achieve instructional goals. In addition, students' emotional states also have positive influence on the learning process and the final results [26]. Therefore, in this development phase, the researcher's goal is to create DSL media that is not only interesting but also capable of evoking a positive emotional atmosphere so that students feel motivated to study effectively.

Alipour and Aminifar [27] strengthen the previous statement regarding the importance of motivation in the world of education. Input data obtained from teachers and lecturers is used as a basis for conducting evaluations at the analysis stage to determine the type. The development of DSL media is tailored to meet the requirements of both teachers and students. Rooted in the outcomes of this phase, it interpreted that interactive and engaging DSL media is essential to facilitate effective learning processes for teachers and help students understand the material. Based on the conclusions obtained from the analysis phase, as a guide in designing DSL media, collaboration is carried out with professionals who have expertise in the field of IT (Information Technology). This IT team has the task of designing media that has been conceptualized previously. Some of the tasks carried out in this stage are compiling material to be embedded in DSL media, arranging DSL features, compiling media validity test instruments, and compiling test instruments that are used to measure the effectiveness of DSL for students. Meanwhile, the IT team is tasked with developing animations according to previously established concepts. From this design stage, a design is produced as seen in Figure 2.



(a)



(b)

Figure 2. Feature interface (a) Start Learning and (b) Explanation of Injection System Components

Figure 2 shows the planned design. The color selection in the design uses attractive color combinations, while interactive features have also been included. In a study [28], it is stated that humans have sensitivity to texture, shape, and color. In the educational area, methods based on the use of color can be an effective approach to improving the quality of learning and student learning outcomes, especially in distance learning situations [29]. This approach is also able to help students remember lesson material better. At the development stage, after obtaining a DSL media design, the next step is to validate the DSL media through the opinion of an expert (validator), where the results are apparent in Table 1.

Table 1. Results of expert validation of DSL media

Expert	Aspects				Average	Category
	Display	Knowledge	Easy to Use	Completeness		
Automotive Field	4.3	4.6	4.2	4.4	4.38	Very Valid
Learning Media Field	3.6	4.0	3.7	3.8	3.78	Valid
Language field	4.0	4.1	4.0	3.9	4	Very Valid

In the table, the validation results from the "Automotive Sector" expert get the highest average score with a display of 4.3, knowledge of 4.6, ease of use of 4.2, and completeness of 4.4. The average value indicates that DSL media is very valid in the automotive sector. Meanwhile, the validation results from the "Automotive Learning Media Field" expert obtained a lower average score, with a display of 3.6, knowledge of 4.0, ease of use of 3.7, and completeness of 3.8. Even though this average value shows high validity, there are significant differences with the automotive sector. The validation results from the "Language Field" expert also gave a high rating, with a display of 4.0, knowledge of 4.1, ease of use of 4.0, and completeness of 3.9. This shows that the DSL medium is also very valid in the language aspect.

This outcome aligns with the conclusions drawn from several prior investigations, which show the importance of these aspects in learning media. For example, Syawaluddin [30] revealed that an attractive and aesthetic appearance in learning media has the potential to enhance student interest and participation, leading to improved comprehension.

Similarly, a study by Haleem [31] indicated that interactive learning media may be more efficacious in enhancing students' comprehension and application of knowledge compared to traditional learning approaches. In addition, the validation results, which show a high level of validity, also support the constructivism theory put forward by [32]. This theory emphasizes the importance of learning that is interactive, practical, and related to students' real contexts in building deeper understanding. In the context of DSL media, the ease of use and completeness found in the validation results allows students to apply their knowledge practically in the context of injection systems.

Overall, the validation results of the DSL media which show a high average score for the aspects assessed provide strong support for the effectiveness and validity of the media. This finding is consistent with the results of previous studies, which emphasized the importance of attractive appearance, interactivity, ease of use, and comprehensiveness in learning media. In addition to developing media at this stage, instrument development is also carried out to evaluate the application of media in learning activities.

The designed instrument is a series of multiple-choice questions consisting of five multiple-choice questions with three different levels of thinking: low, medium, and high levels. This question instrument includes various forms, such as text, images, and videos. Questions that have been prepared through a validation process by five experts in their fields. The results of the validation by these experts show that each question has an average value of 4, which indicates very good quality. After obtaining adequate recognition from experts, further action is to conduct a construct test or construct validation. In this stage, the questions were tested on a limited group of respondents, namely students who had studied injection system theory material (class XII TBSM).

The outcome of the construct test shows that the value of the individual ability measure is -0.24 logit. This indicates that the average student's ability score is lower than the difficulty level of the questions. In addition, the INFIT MNSQ and OUTFIT MNSQ values are 1.00 and 1.12, which indicates that this instrument tends to detect variations in student abilities well and obtain appropriate information from these students.

Table 1. Summary measured person

Category	Total Score	Count	Measure	Model S.E.	In Fit		Out Fit	
					MNSQ	MNSQ	MNSQ	ZSTD
Average	13.4	25.0	-0.24	0.58	1.00	-0.11	1.12	0.40
Standard Error of the Mean	0.7	0.00	0.25	0.01	0.70	0.21	0.22	0.14
P.SD	4.0	0.00	1.33	0.05	0.37	1.11	1.18	0.77
S.SD	4.0	0.00	1.36	0.6	0.37	1.13	1.21	0.78
Maximum	22.0	25.0	2.89	0.74	2.22	2.41	5.89	2.19
Minimum	7.0	25.0	-2.32	0.54	0.61	-1.45	0.37	-.95
True	RMSE is 0.63 with the true standard deviation (SD)		1.17	Separation 1.86 Person Reliaility 0.78				
Model	RMSE is 0.58 with the true standard deviation (SD).		1.20	Separation 1.86 Person Reliaility 0.81				
S.E.	OF Person MEAN =.25							

The correlation between person raw scores and the measurement is approximately 1.00 (with some data missing). The Cronbach alpha (KR20) for the person raw score "test" reliability is 0.78, with a standard error of measurement (SEM) of 1.84 (with some data missing). The standardized reliability for the 50 items is 0.90, person measure of -0.24 logits, indicating that the average score is below 0.0 and suggesting that students' abilities are lower than the difficulty level of the questions. The Cronbach's alpha value is reported as 0.78, while individual reliability is 0.785. These results indicate a Cronbach's alpha value of 0.78. When compared with the table of standard values, the analysis values are in the range of 0.7-0.8, which indicates good quality [33]. As for individual reliability, a value of 0.78 was obtained. When compared with the standard table, this value is in the range of 0.67-0.80, which indicates sufficient quality [33]. In the implementation phase, DSL media was implemented in a trial class, namely class XI TBSM with a total of 30 students. Before the learning process begins, students' abilities are measured, and after the application of the media, students' abilities are measured again.

In the evaluation phase, the resulting data is evaluated. In the evaluation phase, parametric analysis techniques such as the t-test and the n-gain score test were employed. Examination of student scores from both the pre-test and post-test indicates a normal distribution of the data. Because there were 30 respondents, two methods were used, namely Kolmogorov-Smirnov and Shapiro-Wilk. The result of the Kolmogorov-Smirnov for the pre-test value is 0.157, while for the Shapiro-Wilk method it is 0.109. For post-test scores, the result of the Kolmogorov-Smirnov method is 0.200, and that of the Shapiro-Wilk method is 0.120. Both methodologies demonstrate that the normality test conducted on the pre-test and post-test score data yields values greater than 0.05, suggesting a normal distribution.

Table 2. Normality test

Test	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.137	30	0.157	0.943	30	0.109
Postest	0.130	30	0.200	0.944	30	0.120

Upon confirming the normal distribution of pre-test and post-test values, a t-test was conducted. The results of the paired t-test revealed a significance value (2-tailed) of 0.000, which is less than 0.05. This indicates that the DSL media positively influenced the enhancement of XI TBSM students' understanding of motorcycle injection systems.

Table 3. T-Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pre-test – Pos-test	-25.60000	2.25297	0.41133	-26.44127	-24.75873	-62.237	29	0.000

Furthermore, the final analysis is using the n-gain scorer technique. From the results of data analysis, the average n-gain Score is 0.65, which means that the level of effectiveness of DSL media in increasing prior knowledgeability is moderate, while the average n-gain value in percentage is 65.64 percent means that DSL media is quite effective in increasing the capability of a motorcycle injection system [34].

Table 4. N-gain test

	N	Min	Max	Average	SD
NGain_score	30	0.45	1.00	0.6564	0.15714
NGain_Persen	30	45.45	100.00	65.6431	15.71392
Valid N (listwise)	30				

4. Conclusion

DSL is an interactive simulator learning media that is packaged as a software program that can be downloaded and used on a smartphone. DSL makes it easier for teachers to deliver material about injection systems to students. Students can also easily learn material about injection systems independently, because DSL media has several features, namely simulation features, features to recognize the names and functions of components, features to practice reading component damage codes and features to do questions. In addition, DSL media can also be used as a medium for learning injection systems for people who want to become motorcycle technicians. By using DSL media, users of this application can easily and quickly understand how the injection system works on motorbikes and can also easily master injection system problem-solving related to sensors, actuators, and controls.

Users of this application can learn offline using DSL media anywhere and anytime. Using DSL media will increase the number of teachers, vocational school students, and people who have mastered the competence of motorbike injection systems. Based on the discussion outcomes, the paired T-test yielded a value of 0.000, which is less than 0.05. This signifies the acceptance of Ha and rejection of Ho. Consequently, it can be inferred that DSL media significantly enhances the competency regarding the initial understanding of the injection system, while for the level of effectiveness, DSL media got the n-gain score of 0.65 which indicates that the DLS media is at a moderate level. Regarding the n-gain score percentage, which is 65.64%, it signifies that the DSL media is reasonably effective in increasing the initial ability of the TBSM student injection system.

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