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Development of Mobile Learning Media (MLM) to Enchance Students' Understanding of CNC Programming Subjects

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ABSTRACT

This study aims to develop Mobile Learning Media (MLM) technology-based learning in learning programming of Computer Numerical Control (CNC) in vocational high schools. This development is important to improve student competence to be ready for work. Product development design uses the ADDIE technique which includes the stages of analysis, design, development, implementation and evaluation. The application of product development was carried out by using an experimental trial method with a random control group pretest-postest design. The number of research respondents are 120 students with 60 students in the experimental class and 60 students in the control class. Research data includes data on students' learning outcomes and interview data with students after the application of the use of mobile learning which has been developed. Analysis of research data used descriptive statistical techniques and independent sample T-test by using SPSS 2.0 software. The results showed that the use of MLM can facilitate students to learn anywhere and anytime. MLM in CNC learning can provide real learning on how the CNC program is run, so that it can increase students' motivation and learning achievement. MLM supports students' independent learning and makes students become more confident in mastering their competencies, so that teachers can do a variety of jobs easily.

Key words: Mobile Learning Media, Computer Numerical Control, Vocational High Schools.

1. INTRODUCTION

Learning in vocational high schools in Indonesia is currently experiencing various problems, including low teacher competence, lack of infrastructure, learning innovation, and others [1]. As a result, the competence of graduates is not in accordance with the needs of the world of work. Among the study programs that were held, manufacture was in the highest ranking for the weak competence of graduates [2]. CNC programming is one of the main parts of mechanical engineering vocational education [3]. Currently, CNC programming competence is a major indicator of needs in the manufacturing industry [4]. CNC programming learning emphasizes on increasing the efficiency of learning tools with the aim of improving students' skills and abilities [5]. In fact, students have low CNC programming competence. This is due to the lack of teacher competence in the field of CNC programming. In addition, the high cost of CNC machines makes it difficult for schools to buy these machines. The learning process of CNC programming which is carried out without the existence of a real machine results in low quality of learning and misunderstanding conclusions among students about how the CNC program is run.

The problem of the low competency of students' CNC programming must be resolved as soon as possible, because this competency is a competency that is needed in facing the challenges of the industrial revolution 4.0 [6]. The Industrial Revolution 4.0 requires a vocational education curriculum to adapt to real competencies and conditions in the workplace [2], [7]–[9]. This of course makes educators in the vocational education environment have to be able to develop their competencies and skills in order to fulfill the competence of graduates [4], [10]. One method of developing student competence is to determine learning strategies [11]–[14]. Mobile leaning can be used as a media strategy in vocational technical education to support and facilitate student learning in facing the challenges of Industry 4.0 [15].

This study aims to develop a learning strategy by applying technology in the form of mobile learning media (MLM) as a learning medium to solve problems in the CNC learning process. The use of technology can be chosen as an alternative strategy for educators in the learning process [16]. Technology can be used as a learning instruction tool so that it can help improve students' learning achievement of CNC programming [5].

There have been many strategies to use technology to develop student competencies [17]–[20]. Mobile learning is a form of using technology in learning [15], [21]–[23]. The role of mobile learning in learning can connect a real learning environment into mobile devices [24], [25]. However, in fact, currently there are still many educators who still doubt the positive influence of the use of technology it self [26], this cannot be separated from the lack of mastery of educators in integrating technology effectively in learning [21], [27], [28] especially in vocational education.

The development of mobile learning media (MLM) aims to provide learning facilities for students to see firsthand on how the CNC program is run. The use of MLM as a medium for learning CNC programming has not yet been found. Obviously, the high number of mobile device owners among students and teachers makes the use of this learning media must be maximized. Based on the background of the problems above, the research questions in this research are as follows:

- What is the MLM development model for CNC programming ?
- How to implement MLM for learning CNC programming ?
- How are the results of evaluating the use of MLM for students and teachers ?

2. LITERATURE REVIEW

2.1 Mobile Learning

Currently, the use of mobile technology is one of the most preferred learning methods [29]. At all levels of education, the use of mobile learning has been popularly used [30]. The widespread ownership of mobile devices and the increasing availability of other portable and wireless devices have changed the technology-enhanced learning landscape [31]. Mobile learning is a form of technology integration in the classroom [21]. Mobile learning can be used anytime, anywhere and anyone [32], [33]. Mobile devices are very easy to access and use by students in learning [34]. Teachers' knowledge of technology is a major factor in the use of technology in learning [26].

Mobile learning as a technology for learning media has been accepted by many students in formal education [35] and has increased their learning independence [31]. Mobile learning instructional can be used as a bridge between learning outcomes and students' lack of prior knowledge, so that it can increase student activity and motivation to achieve satisfactory learning outcomes [36]. However, the lack of educators' knowledge in integrating technology effectively can hinder the use of technology in the classroom [21], [27].

2.2 Learning CNC in Vocational High School

CNC programming is one of the competencies in vocational High School [37]. CNC programming includes algorithm competencies [38], language, and program code [39]. This requires students to have high reasoning skills and good understanding of the language of the program. CNC learning can be developed with the help of program simulations [40] and virtual reality [37], [41] which can be accessed in technology assistance [5] so that it can provide a real picture of a CNC work in the classroom and add to the effect of joy and enthusiasm of students in learning [42].

3. METHOD

The design of this research is Research Based Development. Development uses the ADDIE model with the stages of analysis, design, development, implementation, and evaluation [43], [44]. The application of product development was carried out by using an experimental trial method with a random control group pretest-postest design. The number of research respondents are 120 students with 60 students in the experimental class and 60 students in the control class. The application of the model was carried out during the Covid-19 pandemic, so that respondents were determined using random cluster sampling. Respondents represent 650 vocational school students in Central Java. Research data includes observations, interviews, and student learning outcomes. Analysis of research data used descriptive statistics and independent sample T-test with the help of SPSS 2.0 software.

Figure 1: ADDIE Model

The ADDIE development model was chosen because it is very systematic and flexible, making it possible to assess technology development in learning [45]. Therefore, it can provide comprehensive clarity about the stages of product development being developed.

4. RESULT

4.1 Development model

Model development adopts the ADDIE concept which consists of analysis, design, development, implementation, and evaluation. The model development stage consists of analysis, design and development. The following are the results of the development of each stage.

Analysis

This analysis stage uses the interview method [46]–[48]. Respondents from the interview stage were students, teachers and school graduates. The interview process aims to gather information [43], [44] related to the CNC programming lessons they have been through. The following is information obtained from the analysis stage:

Table 1: Information on the results of the analysis stage

Respondent	Results
Teacher	1. Teachers have difficulty in teaching due to limited facilities.
	2. The low skills and creativity of teachers in developing instructional media
	3. The teacher becomes the center of learning because it only uses conventional modules as teaching media.
Students	1. Students have difficulty in understanding the programming material presented in the classroom
	2. Students never know how the compiled CNC program can actually work
	3. Students have difficulty in learning independently
	4. Low student motivation and learning achievement
Graduates	1. Low competency of CNC graduates
	2. Difficult to compete in the world of work
	3. Has no reference to learning material after graduation

Design

The content design presented in the MLM will be made based on the achievement of basic competencies and the learning objectives of the CNC programming to answer the problems found during the analysis stage.

The content presentation design in MLM contains CNC programming material, program illustration images, ability tests, CNC job jobs, explanation videos and simulation video programs in the form of virtual reality. The content of the material presented in the form of a combination of text, images, and graphics can attract and increase student understanding [49]. Besides that, this virtual reality video presentation aims to provide a real picture of how the compiled program is run. Hopefully, students can really understand how the program works [50]. Students will be given several kinds of job with a variety of difficulties in order to practice their programming skills.

Development

The development stage of this research consisted of two groups, namely MLM as the media developed and the test instrument as a tool used to measure student competence after using MLM during the learning process. The following is a description of the two stages of development.

1. Mobile Learning Media (MLM)

MLM Developing Stage

The mobile learning media developed in this study is a type of mobile learning that can be accessed offline via mobile phones or computers. The use of media that can be accessed offline will provide freedom for students to study anywhere without time limits or network dependencies. The high number of cellphone use among students greatly supports the use of this learning media.

The learning media developed in this mobile learning is an electronic book in the format of epublication (ePub) [51]. ePub in this study was developed using sigil 2.0 software. The following is a view of the ePub development process in Sigil 2.0 software:

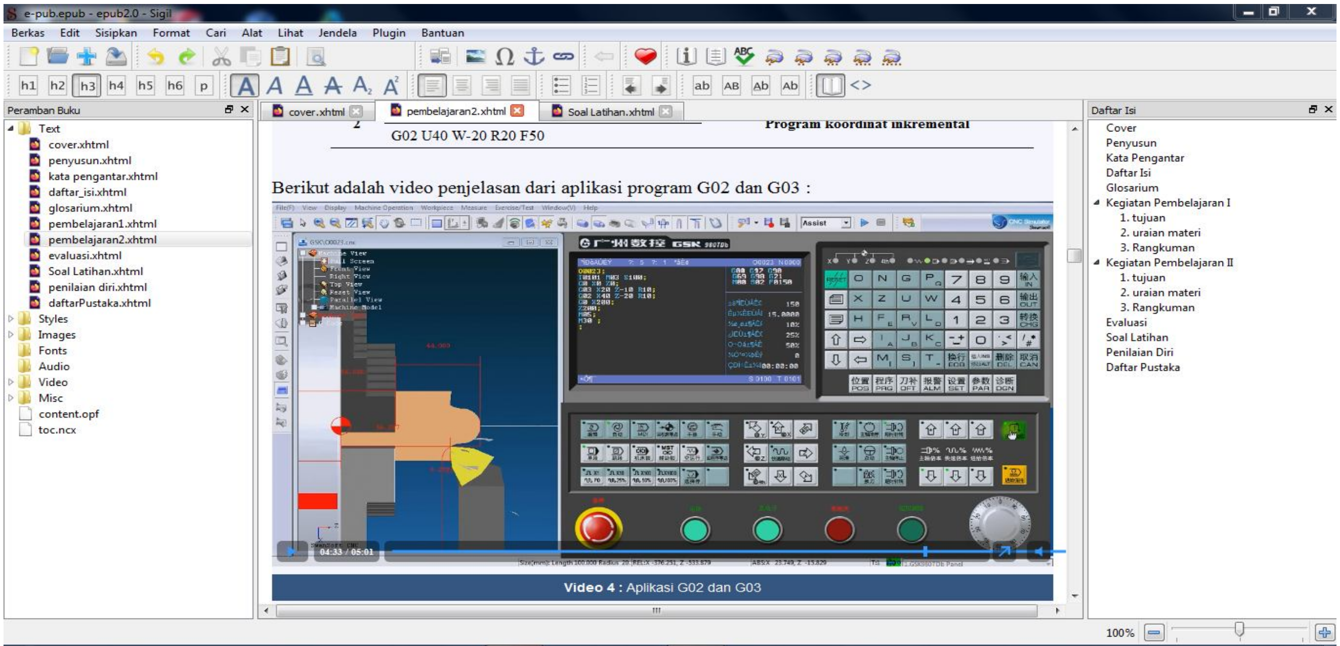

Figure 2: Screenshot of Sigil 2.0

MLM developed through the ePub format can be utilized via mobile devices, including computers, laptops, tablets, and smartphones [15], [16], [22], [28], [52]–[54]. The mobile device used in this study is an android smartphone. The following are the displays of MLM accessed via the Android smartphone.

Figure 3: MLM display on android devices

Product Validation Stage

The MLM products will be carried out in the validation stage by two CNC material experts and two learning media experts. MLM media validation aspects include language, image, video, material and media content aspects. Validation of MLM products is carried out by determining the Content Validity Ratio [55].

2. Development of Instrument Test

The effectiveness of the use of MLM on the competency of CNC programming of students will be tested with a competency test instrument sheet. The type of test used in this research was a multiple choice question with a total of 20 items that had passed the validity test and the instrument reliability test. Instrument testing of competency test questions was given to 74 respondents with the following results:

Item Validity Test

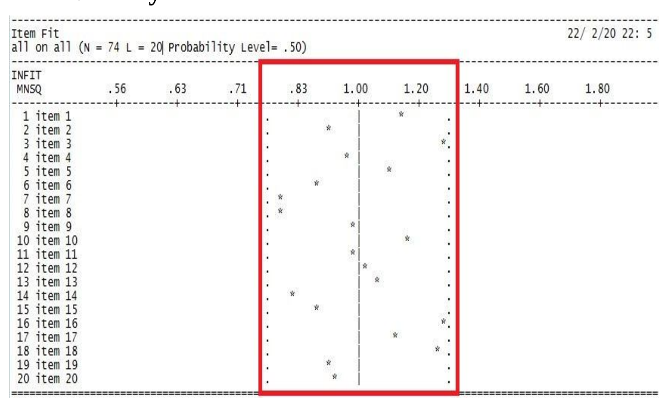

Figure 4: Item Validity Test

The validity of the items used in this study used the Infit Mean Square (MNSQ) criteria with a value range of 0.77 - 1.30

[56], [57]. The results of the validity analysis of the instrument with the help of the Quest program showed that the 20 questions tested were valid, because they were in the MNSQ range.

Item Reliability Test

Reliability test is a reliability test of the consistency of the test instrument items used [58]. If the reliability coefficient criterion is below 0.40 then the significance is bad, if it is between 0.40 to 0.59 then the significance is fair, if it is between 0.60 to 0.74 then the significance is good and if it is between 0.75 to 1.00 then the significance is very good [59]–[61]. The following are the results of the item reliability test :

```
-------------------------------------------------
Case Estimates
all on all (N = 74 L = 20 Probability Level= .50)
-------------------------------------------------

Summary of case Estimates
=========================

Mean                              -.23
SD                                 .36
SD (adjusted)                      .28
Reliability of estimate            .61
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Figure 5: Item Reliability Test

Based on the results of the item reliability test using the Quest program, it shows a value of 0.61, it can be concluded that the item reliability is in the good category.

4.2 Implementation

The MLM product implementation stage was carried out using an experimental trial method. Experimental trials in applying MLM use a random control group pretest-posttest design, involving control subjects as the comparison who do not get treatment and experimental subjects as subjects receiving treatment [62].

Table 2: Group pretest-posttest design model

Group	Sampling technique	Pretest	Treatment	Postest
E	R	O_1	X	O_2
K	R	O_3		O_4

Note :

R	:	Random sampling	O_1	:	Pretest of experimental group
E	:	Experimental group	O_2	:	Posttest of experimental group
K	:	Control group	O_3	:	pretest of control group
X	:	Treatment	O_4	:	Posttest of control group

The application of MLM is carried out on students majoring in mechanical engineering at Vocational High Schools. The number of respondents was 120 students with 60 students in the experimental group and 60 students in the control group.

4.3. Evaluation

The last stage of this research is the assessment and evaluation stage. The data obtained from this research are the students' scores from the learning outcomes of the CNC programming. Analysis of research data used descriptive statistical analysis techniques and independent T-test. Descriptive statistical analysis techniques were used to analyze the effectiveness of media application [63] and the independent T-test was used to analyze the difference in values between the control class and the experimental class [64], [65].

Descriptive Statistical Analysis

Descriptive statistical analysis technique is a research analysis method used to describe, compare, and detect research samples after an action is taken [66]. Descriptive statistical data includes frequency distribution (N), mean and standard deviation [67]. The following are the results of descriptive statistical analysis data for the control and experimental classes:

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test Eksperimen	60	35,00	61,00	43,3167	6,05481
Post-test Eksperimen	60	36,00	77,00	62,0000	10,91104
Pre-test Kontrol	60	31,00	63,00	43,0833	7,40200
Post-test Kontrol	60	31,00	63,00	46,7333	8,39263
Valid N (listwise)	60				

Figure 6: Descriptive Statistics

Based on the data from the descriptive statistical analysis above, it was found that there were differences in the pretest-posttest mean scores in the control and experimental classes. The mean data is a very powerful data measure as a representative of the data that can be analyzed in descriptive statistics [68]. The following is a graph of the mean data of the pretest-posttest scores of the control and experimental class students:

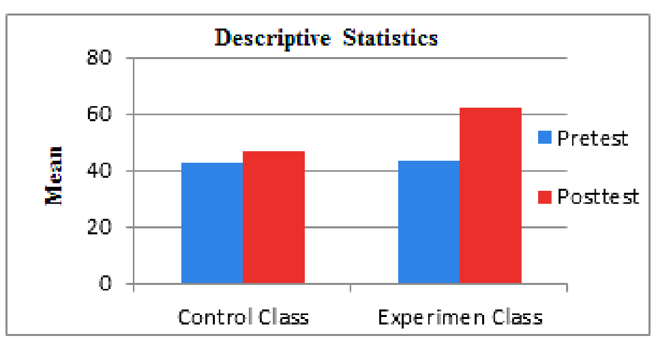

Figure 7: Difference score of mean from pretest-posttest scores of the control and experimental class

Based on the descriptive statistical analysis data, it shows that there are differences in the mean score of each control class and the experimental class. In the control class the mean pretest score is 43.0883 and posttest 46.7333, while in the experimental class the mean pretest score is 43.3167 and posttest 62.0000. The data reports that student competence has increased significantly after using the MLM that has been developed, this can be seen from the difference in the mean posttest score in the control class and experimental class students.

Independent T-test

The independent t-test was used to compare data from two different treatment groups [69]–[71]. The independent t-test can be carried out if the data from the two groups to be tested are normally distributed [70], [72]–[74]. The data normality test can be done using the one-sample Kolmogorov-Smirnov test technique [62], [75]–[78]. The following are the results of the normality test using the one-sample Kolmogorov-Smirnov test technique with the help of SPSS 20 software for the control class and experimental class.

		Kontrol	Eksperimen
N		60	60
Normal Parameters[a,b]	Mean	46,7333	62,0000
	Std. Deviation	8,39263	10,91104
Most Extreme Differences	Absolute	,164	,137
	Positive	,164	,137
	Negative	-,089	-,135
Kolmogorov-Smirnov Z		1,267	1,061
Asymp. Sig. (2-tailed)		,081	,210

a. Test distribution is Normal.

b. Calculated from data.

Figure 8: One-Sample Kolmogorov-Smirnov Test

Data that is normally distributed is data that has a significance value of more than 0.05 [78]–[80]. Based on the results of the normality test with the one-sample Kolmogorov-Smirnov test, the significance value of the control class is 0.081 (> 0.05) and the experimental class is 0.210 (> 0.05), so it can be concluded that the data is normally distributed and the independent t-test can be done. The following are the results of the independent t-test which was carried out with the help of SPSS 20 software.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Value	Equal variances assumed	5,897	,017	-8,591	118	,000
	Equal variances not assumed			-8,591	110,713	,000

Figure 9: Independent Samples Test

The decision made on the independent t-test is if the Sig (2-tailed or two-tailed p-value) less than 0.05, so there is a significant relationship between the two research classes [23], [62], [69], [78], [81], [82]. The results of the independent t-test reported that the value on the Levene's test for equality of variances was 0.017 (<0.05) so it can be concluded that the homogeneity of the data was not fulfilled. Therefore, to read the results of the independent t-test test, it can be seen in the equal variances not assumed in the Sig (2-tailed) column. Based on the value of the independent t-test results obtained by 0.00 (<0.05), it can be concluded that there is a significant difference in value between the control class and the experimental class that applied MLM in learning.

5. DISCUSSION

Based on the results of the development and application of MLM that has been implemented, it can be concluded that the application of MLM in learning CNC programming has increased students' competence. The success of implementing MLM cannot be separated from the positive influence that is experienced and accepted by students [35]. MLM helps students to get information without any limitations [83], therefore, it provides convenience, enjoyment and suitability in learning [84], [85].

The effect of using MLM on learning CNC programming can be seen from the results of the mean value of students between the control class and the experimental class that apply MLM in the learning process. The use of MLM in the experimental class has increased the value of students' learning outcomes which is higher than the control class that does not use MLM as a teaching medium. MLM can improve students' learning outcomes because it can facilitate students in the learning process [53].

The learning process using mobile learning as a teaching medium can improve the quality of learning [16], [86] and increase student involvement in the learning process [87]. MLM can be used as the use of technology as an effort to change the way human learning [88]. Obviously, the large number of smartphone ownership among students [84] can be maximized by educators as an effective learning medium. Provision of programming material that has been compiled in mobile media allows students to freely learn inside and outside the classroom [31] or learn independently [47], [89] or be guided by teachers [26].

Presentation of content according to needs is a strategy that makes mobile learning have a positive influence on student learning [90]. The material presented in MLM is developed in the form of image, text, and virtual reality simulation video. Students report that virtual reality simulation videos help them understand well the program material being taught, therefore, it can improve their interest and motivation to learn [91]. With virtual reality simulation videos, students feel they can see firsthand how the program can actually work, so that misunderstanding in drawing conclusions can be avoided [50].

The use of MLM in the learning process helps reduce the burden on teachers in teaching. The role of teachers in mobile learning is only as a controller and creator of learning scenarios [90]. The results of learning observations report that teacher's role is the key to the successful use of mobile learning in learning [92]. Teachers can choose various teaching strategies that can be combined using mobile learning to improve learning outcomes [93]. Therefore, we suggest that developing teachers' digital literacy skills and changing their mindset towards negative views regarding the use of technology in learning should be done [27], [94]. The important thing to note is that students admit that they have had a lot of learning experiences, not only in the form of score as numbers, but also how to practice creativity and critical reasoning

6. CONCLUSION

The choice of the MLM development model for CNC programming is an important factor in developing this medium. Aspects of content quality and preparation in accordance with competency achievements are important things to consider [95]. The development of MLM material in accordance with the needs provides real knowledge and understanding for students on how the CNC program is run.

The role of the teacher in implementing MLM in learning CNC programming is very important. In particular, teachers must be able to create appropriate learning scenarios and provide feedback on the importance of using MLM in achieving student competence [93]. The use of mobile devices as learning media has a great influence on the learning of CNC programming for students. MLM can replace dependency on learning with CNC machine facilities which must be obtained at a high price.

MLM can facilitate students in learning anywhere and anytime without having to be accompanied by a teacher. Moreover, students can assess their own abilities before receiving reinforcement from the teacher. The use of mobile devices among students and teachers is certainly expected so that its availability can be maximized. Teachers are expected to be able to make creative efforts and take the initiative to develop MLM so that the use of mobile as a learning medium takes a positive role for student achievement.

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