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The Influence of Video-Based Media and Simulator CNC Milling Lite Applications on Student Learning Outcomes of Vocational School in Rembang Regency

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ABSTRACT: This research aims to determine the improvement of student learning outcomes after the application of video-based media and CNC milling lite simulator applications. And to find out how much influence the using of learning media on CNC subjects. This research uses the type of Quasi Experimental Research. The research population was all VS Mechanical Engineering students in Rembang Regency. The results showed that the learning outcomes of students who used video-based media and CNC milling lite simulators could increase by 18.08 or 30% of the previous value. Student learning outcomes in the experimental class were better than the control class with a difference of 9.85 or 14%. Video-based learning media and CNC simulator lite have a positive effect on student learning outcomes as indicated by the regression test equation Y = 69.44 + 0.16X. A total of 77.8% of students agreed with the using of video-based media and CNC milling lite simulator applications.

KEYWORDS: CNC milling, video-based media, CNC milling lite simulator

I. INTRODUCTION

The industrial revolution from time to time continues to experience rapid changes, from 1750 the first industrial revolution (1.0) to the current fourth industrial revolution (4.0). Industrial machines are now computerized and interconnected with one another. The industrial revolution and the development of Technology 4.0 are closely related to the use of NC/CNC (Numerical Control / Computer Numerically Controlled) in various machining and manufacturing processes. Afzeri, Sutjipto, Muhida, Konneh, and Darmawan (2011) explain that "*Increasing the demand for effectively use of the production facility requires the tools for sharing the manufacturing facility by remote operation of the machining process.*"

The increasing demand for effective use of production facilities requires tools for sharing manufacturing facilities with remote operation of machining processes. A remote-controlled CNC can cut machining time and save production costs.

CNC machines are widely used to produce various components that are difficult and require high accuracy. The need for industry in producing various technological needs quickly, accurately and in large quantities makes the need for CNC very much needed today. The field of education and research currently also uses CNC to produce various useful research results, besides that NC / CNC technology is also needed in various industrial fields including the medical industry, furniture & furniture, automotive, space equipment, electronics and military. The machining industry plays an important role in national development by producing engineering components needed by other industries.

VS is an educational institution and trains students to be ready to work in the industrial world or open entrepreneurial opportunities in the business world. The purpose of VS is in line with the definition of Hollander, A. and Mar, N. Y. (2009) which states that "*Technical and Vocational Education and Training (TVET) is concern with the acquisition of knowledge and skills for the world of work*." Vocational education and training is a means of preparing a person's knowledge and skills before entering the world of work. A person who will enter the world of work will prepare themselves according to their field of expertise. A person's competence in a particular field is a consideration for companies in recruiting competent and professional workers.

Modern industrial production systems require a skilled and professional workforce to carry out their duties. Wilson and Buchanan (1988) revealed *"The findings from research in three companies demonstrate that in the engineering industry, technical change can have both positive and negative effects on the utilisation of skill, and thus on levels of skill in the industry."* Research conducted on 3 (three) companies shows that in the engineering industry, technical change can cause both positive and negative effects on skill utilization. Workers will experience both positive and negative technical changes in the company. Workers' skills to be able to adapt to these changing situations are needed. So that the industry's need for experts and professionals must be prepared through vocational schools or now known as Vocational Schools (VS).

The Influence of Video-Based Media and Simulator CNC Milling Lite Applications on Student Learning Outcomes of Vocational School in Rembang Regency

Vocational education in Indonesia, especially vocational schools, currently still has a gap with the World of Business / World of Industry (WB/WI). Huda (2023) Chairman of Commission X DPR RI revealed

...the standard of vocational education must be the same as the standard of job needs. The gap concerns the formulation of the curriculum. The education curriculum in vocational schools, with the material skills and competencies that are the criteria for entry in the world of work are still different.

The education program in VS still needs to be reviewed because of the delay in updating technology and information with WB/WI. Industries that are experiencing rapid development in the use of technology and automation have not been able to be followed quickly by VS. The type of study program, educational materials, educational media, learning models and methods, evaluation, and certification are still determined by the main element, namely the government. The government places high demands on the targets of VS graduates but this is not accompanied by the provision of fast and capable infrastructure, technology and learning media to catch up with WB/WI. Romadin (2021) reveals that

...the results of labor career analysis on the position of CNC Operator in the manufacturing industry, which includes: (1) setting up CNC machines, (2) making programs manually and using CAM applications, and (3) operating and monitoring using the siemen control system. Mastery of these competencies will support the next career path.

The results of observations that have been carried out at VS in Rembang Regency show that the mastery value of Machining Engineering students in CNC subjects is still low, the lack of learning media used by teachers, the unavailability of sufficient computer equipment, and the inadequate CNC Teaching and Learning Process room. The observation results show that 48.57% of students get daily test scores less than MCC (Minimum Completeness Criteria) so it needs to be improved. It is known that out of 35 students in one class, on average there are still 17 students with theory and practice scores below 65. While students who scored 65 to 70 amounted to 37.14%. And students who scored >70 amounted to 14.29%. This grade completeness can be achieved by requiring additional assessments that prioritize differentiated learning in the form of remedial, self-assignment, or portfolios.

Research conducted by Abizar, H., Fawaid, M., Nurhaji, S. and Pambudi, A. R. (2020) states that the skills of students who use simulators (swansoft) in CNC subjects increase significantly. Student activeness also increased after using the simulator. From this study, it is known that there is a positive impact of using simulator applications applied to CNC subjects.

The CNC learning room so far does not have a special room and is still one with other machining workshop learning activities. CNC programming requires learning facilities such as computers and software that support it so that it can improve students' understanding and skills. The lack of learning facilities with computers and MasterCAM software results in delays in students understanding and practicing learning materials. The computer laboratory, which has a capacity of 28 units per room, cannot be fully installed with the MasterCAM application. Half of the available facilities (14 units) still have specifications below industry standards, so the use of the laboratory as a means of CNC programming practice is still an obstacle. 1 computer unit is used for 2-3 students in each lesson. Ideally, 36 computers (1 student for 1 computer unit) are needed in one room that has MasterCAM software installed, so that learning can be more effective and optimally achieved.

The utilization of software used to assist CNC simulation also has several advantages, as explained by Unver, E., Coolers, P., and Mavromihales, M. (2001) that training using simulators can cut training time before the purchase or delivery of CNC machines. Simulators can also save the cost of providing training facilities to students when the availability of CNC machines is still limited. The use of such applications is also in line with current trends.

Researchers tried to compare the effect of using two different learning media on student learning outcomes. Learning videos are currently widely used as learning media that are familiar and widespread on the internet. While the CNC milling lite simulator application media has not been widely used in Teaching and Learning Activities.

Valvo, E. Lo., Licari R., and Adornetto A. (2012) in their research on the use of CNC milling simulation in engineering education, stated that “This simulator lets the users not only verify the toolpath but also detect any possible collision by using the very computer which controls the milling machine.” The research shows positive results, the simulator can tell the user to be able to verify the cutting tool and find out errors when there will be a crash (collision) before the program is ready to be applied to the real CNC milling machine. Valvo et. al. concluded that the system is very efficient and easy to use, and is said to be a powerful tool in technical education.

Both have their own advantages and disadvantages, so it is necessary to research the use of these two learning media. Both learning media can be easily accessed by students because every learner has a gadget as a means of supporting Teaching and Learning Activities.

Based on this background, the causes of the problem can be identified, including:

1. Learning facilities that are not industry standard.
2. The capacity of most computer devices is still below industry specifications.
3. Video learning media and android simulator applications have not been applied optimally.
4. Student learning outcomes on NC/CNC machine programming method material are still low.

5. Teacher as the center of learning.
6. Students are less active and initiative.
7. Students have not maximized the use of available technological devices.

II. RESEARCH METHODS

The type of research used is quantitative research. The research used is a type of quantitative research by utilizing the quasiexperimental method. This research requires a research design, the design that will be used is a pre-test post-test control group design.

This research was conducted on :
Date: September 30, 2024 - November 28, 2024
Time: 12.50 WIB - finish
Learning Hours: 8-11
Place : SMKN 1 Rembang and SMKN 2 Rembang
Address : Jl. Rembang-Lasem No.KM, RW.4, Kaliuntu, Pasarbanggi, Kec. Rembang, Rembang Regency, Central Java 59219.

The subjects of this study were students in the Competency of Mechanical Engineering in Rembang Regency. The population involved in this study were students at the Machining Engineering Competency in Rembang Regency The population at the Machining Engineering Competency in Rembang Regency totaled 177 students.

The research sampling was carried out by randomly dividing students majoring in Mechanical Engineering class XI into two groups, one group containing 30 students in the experimental class and 30 students in one group in the control class.

The variables referred to in this study are the Application of Video-Based Learning Media (X1), CNC Simulator ApplicationBased Learning Media (X2) and Learning Outcomes (Y). The factors studied include the accuracy of the application of media-based learning, the effect of activity on learning outcomes, the effect of the application of video-based learning media, CNC milling lite simulator application-based learning media on learning outcomes, and the effect of the application of video-based learning media and CNC milling lite simulator applications on learning outcomes.

III. RESULT AND DISCUSSION

A. RESULT

This research uses a type of Quasi-Experimental Research that produces numerical data. This study aims to measure the effect of the use of video-based learning media and CNC milling android simulator applications on student learning outcomes at the Machining Engineering Expertise Competency in Rembang Regency. From the population of class XI students of Mechanical Engineering in Rembang Regency which amounted to 177 people, 60 students were taken as research sample respondents. The 60 students were divided into 2 groups, 30 students were in the control class and 30 other students were in the experimental class.

The research data were obtained from the results of pre-test, post-test and questionnaires from the control class and experimental class. The pre-test and post-test questions each consisted of 40 multiple choice questions. While the questionnaire used consists of 2 types of questionnaires, consisting of a questionnaire used to measure how much the effectiveness of the use of learning media that has been applied and a questionnaire used to measure student skills in CNC Milling preparation and programming.

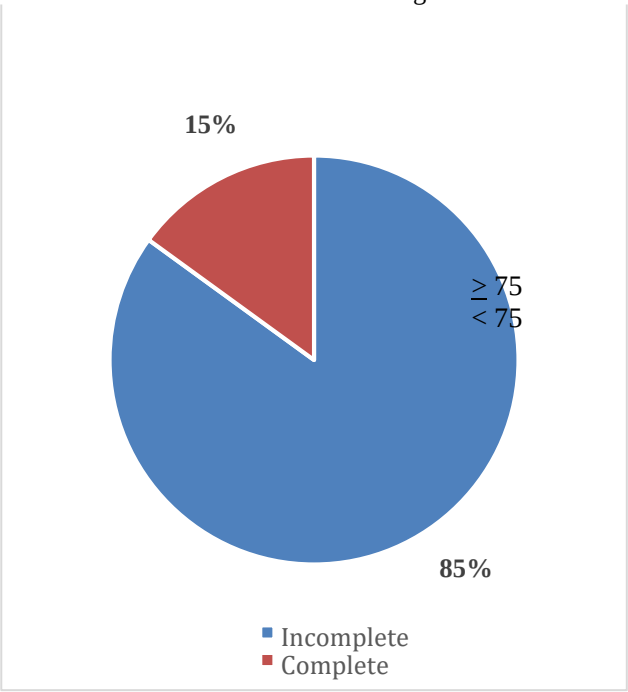
Furthermore, the initial stage of data analysis was carried out in the form of a pre-test in both classes. Then the experimental class was given the treatment of using video-based learning media and android-based CNC Milling simulator applications.

Table 1. Distribution of CNC Milling Programming Scores of the Initial Stage

No	Value	Frequency	Percentage	Category
1	≥ 75	9	15%	Completed
2	< 75	51	85%	Uncompleted
Total		**60**	**100%**	

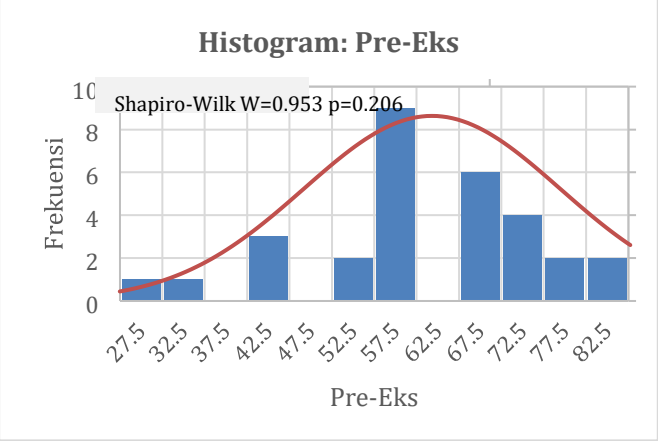
The table above shows that the student completeness score is still relatively low, as many as 51 students scored below 75. Meanwhile, 9 other students or 15% of the research sample fell into the complete category. The magnitude of the incompleteness in student grades is caused by several factors that have been explained previously. So there needs to be action to improve the situation so that student scores become better.

Picture 1. Pie Chart of CNC Milling Pre-Test Score



From the table above, it can be concluded that learning with lecture/conventional methods and conventional learning media has not been able to realize a more active learning process and critical thinking, so there is a need for learning innovation, especially in the learning media applied so that it can activate students' critical thinking during the CNC milling programming process.

Picture 2. Histogram of Experimental Class Pre-Test Score



Picture 3. Histogram of Control Class Pre-Test Score

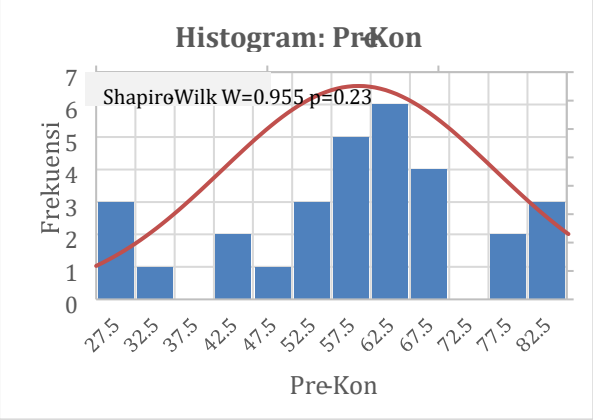


Table 2. Distribution of CNC milling Post-Test Score of Experimental Class

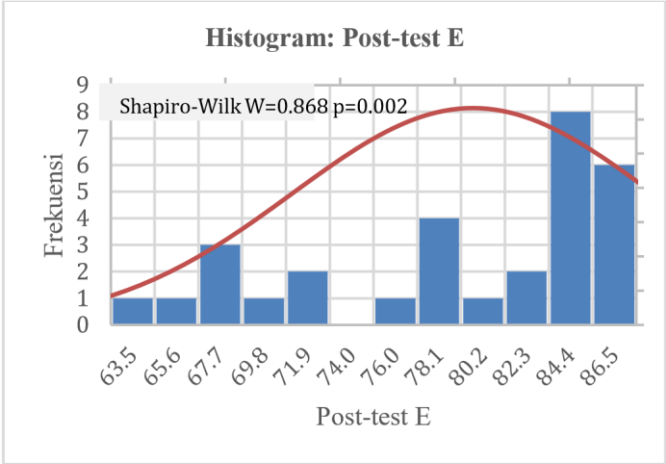
No	Value	Frequency	Precentage	Category
1	≥ 75	22	73%	Completed
2	< 75	8	27%	Uncompleted
Total		**30**	**100%**	

Table 3. Distribution of CNC milling Post-Test Score of Control Class

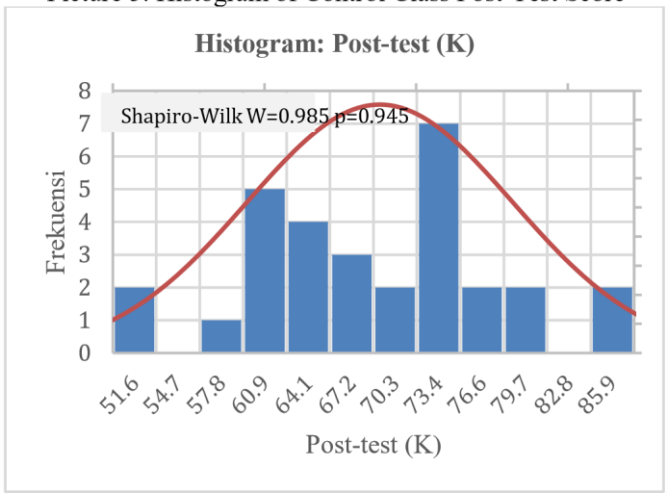
No	Value	Frequency	Precentage	Category
1	≥ 75	9	30%	Completed
2	< 75	21	70%	Uncompleted
Total		**30**	**100%**	

The results of the post-test data from the two classes above show a difference in the percentage of completeness of the scores from the experimental and control classes. The experimental class as many as 73% (22 students) reached the minimum completeness, while in the control class as many as 30% (9 students) could reach the minimum completeness. After receiving different treatment in the two classes, the mean/average value for the experimental class was 79.3 and the control class was 69.7.

Picture 4. Histogram of Experimental Class Post-Test Score



Picture 5. Histogram of Control Class Post-Test Score



Based on the results of the normality test, it is known that the distribution of values in the experimental class is uneven so that the data from the experimental class is declared to be abnormally distributed. While the normality test in the control class was declared normally distributed because the post-test scores were more evenly distributed. Because the post-test data in the experimental class was not normally distributed, the homogeneity test was not carried out and then the mean difference test was carried out using the Mann-Whithney U-test.

Data on student post-test results in the experimental class used a non-parametric test, namely the Mann-Whitney U-test because there was data that was not normally distributed. The test uses a significance level of 5% or 0.05. The hypothesis used in testing the difference in means is the Mann-Whitney U test are shown in the following table.

Table 4. Mann-Whitney U-test

U	z	asymptotic p	exact p	r
179	-4.03	<.001	<.001	0.52

Based on the Mann-Whitney U-test results in the table above. The Mann-Whitney U-test data shows that there is a difference between the post-test scores in the experimental class and the control class with a significant difference. The significant difference is known from the p-value which is 0.001, which means the p-value < α or H0 is rejected and Ha is accepted. So it can be concluded that there is a difference in the average post-test scores of students in the experimental and control classes.

The homogeneity test does not need to be done because there is data that is not normally distributed, so then the mean difference test is carried out using a non-parametric test (Wilcoxon test). Non-parametric tests using the W-test can be used if there is data that is not normally distributed and the samples are tied. The W-test conducted uses a significance level of 5% or 0.05.

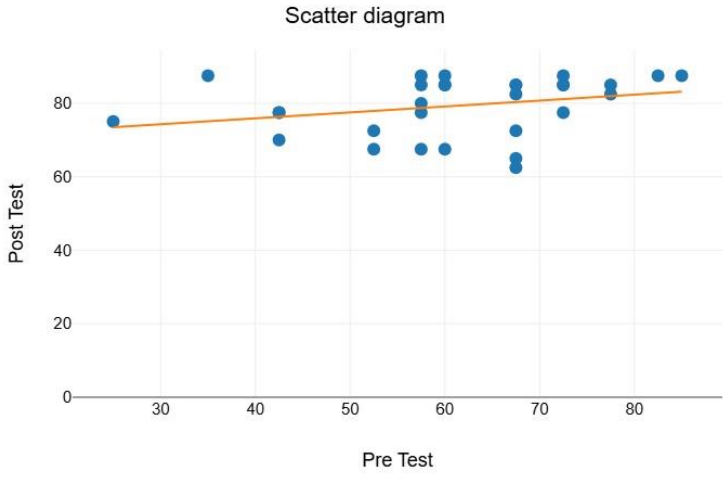
Furthermore, the hypothesis is formulated with the results of the W-test calculation obtained as follows:

Table 5. Wilcoxon W-Test Results

	W	z	p	r
Post-Test – Pre-Test	6.5	-4.65	<.001	0.85

From the hypothesis testing results above, W=6.5, z=-4.65 and a p-value of 0.001 were obtained. Since the p-value < α, then H0 is rejected and Ha is accepted. It can be concluded that there is a significant difference in the experimental class after the application of video-based learning media and learning mediabased on the CNC milling lite simulator application.

Picture 6. Experimental Class Linear Regression Graph



The r value in the W-test will strengthen the hypothesis, it is known that the r value is the value of the influence between variables. The applicable regression coefficient is Post-Test = 69.44 +0.16 - Pre-Test or Y = 69.44 +0.16X. When all independent variables are 0, the post-test variable value is 69.44. This proves that the application of video-based learning media and CNC milling lite simulator applications are learning media that can be used to improve student learning outcomes in CNC milling programming material.

B. DISCUSSION

This study aims to determine how much influence the use of video-based learning media and android simulator-based CNC milling lite compared to conventional learning methods and media. The results of research observations show the influence between the use of interactive learning media on student learning outcomes. Video-based learning media used can increase student focus on the material being studied, and android simulator-based learning media can activate students' critical thinking to complete projects given by the teacher.

This applied learning media makes changes to student activeness and learning outcomes. Students' understanding of CNC milling programming material increased significantly. There was a 30% increase in grades from the previous grades in the class that received treatment with the use of both learning media. The cognitive scores of students who were above the completeness reached 73%, and 27% of students still scored below the completeness. Whereas in the class that did not get the learning media treatment, the increase in students' cognitive scores was still low.

Student activeness in the control class showed results of 72.92% and in the experimental class showed results of 82.92%. There is a difference in activeness of 10% more active experimental class than the control class. Video-based learning media and android simulator animation before being applied to students, student initiative to ask questions and in doing CNC programming is still low. When KBM using video-based learning media and android simulator animation is applied, it begins to show student participation and activeness in participating in learning and enthusiasm in project completion. Students begin to have the initiative to ask friends and teachers about material that has not been understood, in learning students look very active trying and testing CNC milling programming independently using an android simulator on their gadget. Then after the implementation of learning with video-based learning media and android simulator animation, students are able to learn independently. Teachers no longer dominate during learning, students are able to organize and discuss in groups to solve problems encountered and complete the project work obtained.

The results of data collection through questionnaires given to students in the experimental class, it can be seen that the dominant student responses agree and strongly agree.While the negative student response statements are disagree and strongly disagree.The score of the overall approval response that students give regarding the use of video-based learning media and android simulator animation is 555, so it can be concluded that students agree to the use of video-based learning media and android simulatorbased CNC milling lite.

Students gave an agreeable response to the use of video-based learning media and based on the CNC milling lite android simulator as shown in the average percentage value reaching 77% approval.The response given by students after the application of video-based learning media and based on the CNC milling lite android simulator is very agreeable if the video-based learning media and based on the CNC milling lite android simulator are applied to CNC subjects.Students feel that they can develop their abilities and find new knowledge from the existence of video-based learning media and based on the CNC milling lite android simulator. Students' positive response to this video-based learning media and CNC milling lite android simulator-based can have a positive influence on student learning outcomes from the previous one.

This research has been carried out to the maximum to achieve satisfactory results, but some obstacles are still found so that this research still has limitations that must be considered. The limitations of this research include:

1. The implementation of the learning model with the Project Based Learning model requires a long time due to the length of the stages that must be passed, namely orientation, design, scheduling, implementation, evaluation, and reflection.
2. The use of video-based learning media requires a sufficient internet connection so it needs to be ensured that students are facilitated.
3. The use of learning media based on the CNC milling android simulator requires an android type of at least android 4.2 and newer, as well as sufficient cellphone memory capacity to install the application (at least 50MB).
4. The use of learning media based on the android CNC milling simulator (unpaid) is limited in the use of tools / cutting tools so that to use complete tools a subscription is required and paid.

IV. CONCLUSIONS

Based on the results of research and discussion, it can be concluded as follows:

1. Student learning outcomes after the application of video-based media and CNC milling lite simulator in the experimental class, experienced an increase in the average student score. It is known that the difference in the average pre-test and post-test scores of the experimental class is 18.08 or an increase of 30% from the previous value. The difference in post-test scores of the experimental class is higher than the control class by 9.85 or 14%, so it can be concluded that there is a significant difference in students' final abilities between the experimental and control classes after the application of video-based media and CNC milling lite simulators in the experimental class.

2. Video-based Learning Media and CNC milling lite simulator applications are proven to have an effect on the learning outcomes of Machining Engineering students on CNC milling programming competencies, this statement is supported by the correlation coefficient (r) = 0.85 and the regression equation Post-Test = 69.44 +0.16Pre-Test or Y = 69.44 +0.16X. When all independent variables are 0, the value of the post-test variable is 69.44. Video-based Learning Media and Android CNC milling Simulator if implemented properly will increase student learning outcomes (positive) which is 69.44.

Student activeness in the experimental class showed a 10% higher percentage when compared to the control class. Student activeness in the control class during learning can be categorized as "Active" while in the experimental class it can be categorized as "Very Active".

Student responses in the experimental class to Video-based Learning Media and CNC milling simulator lite were interpreted as "Strongly Agree" to the application of Video-based Learning Media and CNC milling simulator lite on CNC milling programming. On average, 77.8% of students approved the application of the two learning media to be used in CNC milling programming material.

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