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Implementation of electro-pneumatic practices learning model based on troubleshooting to improve students' creativity

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ABSTRACT

This study aimed to develop students' creativity through troubleshooting learning models in practical electro-pneumatic. This study was conducted during the Covid-19 Pandemic where learning was carried out online. This troubleshooting practice learning is applied to simulation applications so that it can be a solution in implementing learning that cannot be carried out directly. This study used a quasi-experimental researched method with a controlled group pretest-posttest design pattern. The sample consisted of 60 students majoring in mechanical engineering, State University of Semarang was divided into two classes. The experimental class applies the troubleshooting-based practical learned model, while the controlled class implements practice learned without using the troubleshooting learned model. Based on the research result, the pretest mean value in the experimental group was 76.26 with a standard deviation of 11.97, while the pretest mean value in the control group was 74.53 with a standard deviation of 10.31. Meanwhile, the posttest mean score in the experimental group was 77.5 with a standard deviation of 7.62, while the posttest mean score in the control group was 64 with a standard deviation of 8.84. The average post-test score in the experimental group is higher than the control group so it can be concluded that the learning outcomes of the experimental class using a troubleshooting-based practical learning model are higher than the control class where troubleshooting learning models are not implemented in electro-pneumatic practice.

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INTRODUCTION

The rapid development in technology makes the world of education must adapt and be responsible for creating a good system to create competitive human resources and be ready to face rapid changes. Educational institutions must apply various kinds of learning strategies to improve the quality of learning. The role of educational institutions is very important to prepare educators to create good Vocational Secondary School (VSS) graduates. Media use in learning has a role in creating higher-quality learning processes and outcomes. Learning is not only theoretical but also practical, economical, and easy to access so that learning from pneumatic and hydraulic practices will be stronger in the system (Munadi, 2012). In Vocational Secondary Schools (VSS), learning media in practice is needed to facilitate students' understanding because VSS is an educational institution that prioritizes practical learning without excluding theoretical learning to educate graduates ready to work. Practical learning can equip students to prepare themselves to achieve

competence in the world of work. The right learning process is very influential in achieving a good level of student understanding.

Vocational education equips students with various knowledge, skills, and educational experiences so they can be involved in certain jobs needed for themselves, the field of work, and national development (Murniati & Usman, 2009). Another definition Another definition in Government Regulation of the Republic of Indonesia Number 29 of 1990 Article 2 Paragraph 1 concerning the purpose of vocational schools states that VSS is a school at the secondary level that prioritizes the development of students' abilities to be involved in a job. Vocational education is an educational system that focuses on preparing students to face the job market (Djojonegoro, 1998). In accordance with what is described above, vocational education is an education system carried out in various fields as provisions by students to gain knowledge, skills, and experience to be able to face the world of work according to their choice or to go to a high level. One form of vocational education is VSS.

In an effort to create quality graduates, vocational secondary schools must innovate in perfecting the learning system. One of them is to prepare qualified prospective educators who can carry out the learning process according to their fields so that they can create graduates who can master the material and practice well and create quality graduates. Higher education is an institution that aims to produce professional and quality graduates in the world of education. The quality of learning needs to be improved to provide good services to create competent prospective educators. According to Pusparisa (2019), the number of unemployed vocational school graduates decreased to 6.9%, from 9.3 million to 8.3 million unemployed, while the number of unemployed university graduates has increased quite drastically. Diploma graduates increased by 8.5%, from 6.3 million to 6.9 million unemployed. The increase in the number is still somewhat smaller than the increase in unemployment for S1 graduates. Data shows that the number of unemployed undergraduate graduates has increased by 25%, from 5 million to 6.2 million unemployed. According to these data, higher education graduates need more attention, so they do not continue to increase.

The purpose of this study is to compare the creativity of the class that uses the troubleshooting-based practical learning method and those that do not use the troubleshooting-based practical learning method. This goal is one of the efforts to create a better practical learning system when learning is carried out online. In addition, this research was also conducted to find out the effect of the Troubleshooting-based practical learning method on students' creativity so that this learning model can be applied in practical learning with similar competencies.

Some factors that can influence learning are internal and external. Internal factors can occur in each individual. These include motivation, interests, talents, and creativity. External factors are influenced by the environment, such as educators, media, infrastructure, facilities, and the learning environment. These factors are interrelated, so there is a need for development to achieve maximum learning outcomes. The internal factor that is still not being paid attention to is creativity because every student has various levels of creativity. In addition, the creative thinking skills of students in Indonesia are still not being paid attention to.

The results of Reynawati and Purnomo's (2018) research show that in the creativity category, the average student's creative thinking skills score is 28.53. Most students cannot train their thinking skills (Rizal et al., 2018). Students' creative thinking skills showed poor test results (Sirait et al., 2018). Students can only answer by providing solutions in terms of creative thinking. The dimensions of fluency, flexibility, and originality are still lacking. Developing the creativity aspect of the younger generation is one of the important aspects so that this nation has a competitive and independent generation in the era of globalization (Triyono et al., 2017). These elements have been employed to construct a framework of creative problem solving, which may be used to foster creativity among young people under instruction and provide a cognitive explanation of the origin of new ideas (Aldous, 2012). Therefore, it is necessary to hone and develop creativity through a learning model in accordance with existing fields.

Educators as teaching agents for students can choose a learning model for the lessons to be delivered. This learning model is expected to be innovative for developing students' internal factors, especially creativity. Educators must also innovate in every existing development in order to make it easier for students to understand lessons and produce competent graduates. Internal factors are the

main capital in shaping students' character so that when they graduate, they can develop their potential independently. The purpose of developing a learning model is to develop the quality of human resources so that they are better prepared to face national or global competition. In the current development, educators are expected to be able to innovate to prepare students to face any changes, in accordance with Laws of the Republic of Indonesia No. 20 of 2003 concerning the National Education System, which reads "paying attention to the dynamics of global development." One of the cases of contemporary development is tighter labor competition, the lack of individual ability to develop independently, and the development of science and technology so that we are required to adapt quickly. Thus, the times that exist require each individual to be better prepared to get every opportunity. This is a challenge that must be faced so that we as Indonesians have a high level of competence both nationally and globally.

Department of Mechanical Engineering, Semarang State University, a vocational education institution in the technology field, has three Study Programs. These study programs are S1 Mechanical Engineering Education, S1 Automotive Engineering Education S1, and S1 Mechanical Engineering. Two of the three study programs are study programs that produce prospective educators for secondary vocational schools. In addition to being educators at VSS, graduates from the Mechanical Engineering department can compete in the industrial world according to their respective choices. So it is necessary to have a good debriefing to create competent graduates.

Therefore, improving the quality of learning is necessary so that students can master theoretical and practical fields. To improve the quality of practical learning, both the learning curriculum and the completeness in practice need to be improved. The curriculum and the completeness of practical facilities and infrastructure are important factors in creating a conducive learning atmosphere for students. A conducive learning atmosphere can make it easier for students to improve their abilities and skills individually and in groups. This can be a reference for creating competent graduates.

Electropneumatics is one of the competencies in the pneumatic hydraulic course in the mechanical engineering department, which contains theory and practice in the implementation of learning. Pneumatic competence is very important for the industrial or production world. According to Sumbodo et al. (2008) stated that compressed air can be used in many production purposes, for example in creating manual mechanical movements, such as pressing, pushing, sliding, lifting, etc. Pneumatics is based on the fluid power system principle, which states that gases and liquids under pressure are used to transmit energy over long distances. Such systems are referred to as fluid power systems (Barala et al., 2014).

Pneumatic components can also perform mechanical movements, such as air cylinders, pneumatic motors, translational robots, rotations, or combinations. Electro-pneumatics were also extensively used in manufacturing, assembly, and packaging systems. Relays have been integrated into electro-pneumatic control systems to satisfy the increasing call for more flexible automation (Pereyras, 2020). For a continuous and flexible production process, the mechanical movements of the pneumatic actuators can be combined into mechanical movements. In the field of production, the use of the pneumatic system has experienced rapid development, especially in manufacturing, electronics, pharmaceuticals, food, chemistry, etc. Compressed air (pneumatic) was chosen as the control system in the automation process because pneumatics has the following advantages: easy access, elimination of dust and hazardous chemicals, easy distribution via small ducts (hoses), explosion-proof and short circuit safety hazards, overloading, no sensitivity to temperature changes, etc.

In the pneumatic and hydraulic course at the Department of Mechanical Engineering, Faculty of Engineering, Semarang State University, the mastery of the practicum field is not maximal in electro-pneumatic practice. The lack of learning outcomes is because, in the learning process, students feel that using time is less effective, so students lack understanding in mastering the knowledge given. The time allocated is not sufficient to increase understanding. Inefficient use of learning time forces students to learn independently, which causes them to lack understanding. Students are expected to be able to be more creative independently in developing the lessons that have been given outside the existing class hours. Students should not only be fixated on the material (series) that has been given. If you only stick to the material (series) that has been delivered, there

will be less creativity in learning development. Therefore, students must be innovative and creative in developing lessons. The importance of creativity in this competency is that students can hone skills in creating and assembling new series according to the conditions to be faced. So, this factor is very influential so that students can increase their potential independently after graduating.

There are several factors behind success in learning. One of them is learning media. The existence of good media will help lecturers provide learning materials and increase student understanding of learning materials. The use of media must be in accordance with the curriculum with goals and abilities in accordance with the achievements of students in their studies. Fluidsim simulation applications and electro-pneumatic props are learning media that can be applied in electro-pneumatic competencies. In the application of media simulators, a problem-solving learning strategy is needed in solving problems related to the pneumatic electro system to improve students' skills and competence in understanding components and understanding the pneumatic system circuit to the maximum, so we need appropriate learning media to overcome the limitations of practical learning (Ramdani et al., 2019).

To develop and hone student creativity, it is necessary to apply a troubleshooting learning model. Troubleshooting is a model for finding root causes systematically so that problems can be resolved and potential causes of problems can be eliminated. When problems inevitably arise, operators spend considerable time troubleshooting those problems by identifying root causes and correcting them. The cost of troubleshooting is substantial (Attariyan & Flinn, 2010). Troubleshooting is usually associated with solving problems physically or mechanically in the work system so that the system can return to normal operation. Argues that the concept of troubleshooting is an effort to find problems with components or work systems and provide solutions so that the system can return to normal work (Jonassen, 2010).

The troubleshooting process is often used to diagnose the cause of failed products in the production systems. This method is employed to repair rejected products and to find the root causes of problems so that failed products can be usable again (Mahmood et al., 2016). Misconfiguration troubleshooting is particularly challenging because configuration information is shared and altered by multiple applications (Wang et al., 2004). Troubleshooting allows students to hone thinking skills so that they can increase creativity. However, this troubleshooting learning model has not been implemented even though this troubleshooting model can not only be implemented in teaching aids but can also be implemented in the fluids simulation application, which can be studied by students independently outside of class or practical hours.

In 2020, Indonesia experienced a pandemic in the face of the Covid-19. This pandemic makes the world of education conduct online learning. This is in line with the Minister of Education and Culture of the Republic of Indonesia in letters No. 2 of 2020 and No. 3 of 2020 concerning procedures for handling and preventing the development of the Covid-19 virus. One of them is implementing online learning from home and working from home (WFH). Online means connecting to a computer network. According to Thome in Kuntarto (2017), online learning is learning that utilizes online technology such as multimedia, video, virtual courses, online text animation, voice messages, email, conference calls, and online video streaming.

Online learning in question is a learning system that is directly connected to a computer or other device connected to the internet in its implementation. E-learning activities can increase the effectiveness and efficiency of learning activities. The effectiveness and efficiency are in terms of applying the principles of learning that are made easier and the various benefits offered to be able to increase learning time in the classroom (Wang et al., 2020). E-learning for vocational education should make it easier for students to access anytime and anywhere using electronic media such as smartphones (Ahmad et al., 2020). It is widely acknowledged that online learning has been common practice in Indonesia and in most other parts of the world due to the outbreaks of the Coronavirus, which have forced people to study from home and work from home (Mulyanti et al., 2020).

Coronavirus has been impacting the face-to-face education system of developing countries. Therefore, developing countries should enhance broadcast teaching, online teaching, and virtual class infrastructures (Tadesse & Muluye, 2020). Students feel that online learning has not provided better experience and productivity in mastering competencies but can provide motivation and ease in their learning (Syauqi et al., 2020). In this electro-pneumatic practice learning, the use of simulations using

the application of the fluid will be maximized. The simulation aims to provide an initial picture to students before being applied to an electro-pneumatic teaching aid or system. However, the practice of using teaching aids will be difficult to implement during a pandemic like this. Therefore practical learning using this simulation will be carried out optimally, and a troubleshooting-based learning model can be implemented in the simulation application.

RESEARCH METHOD

In this study, researchers used quantitative methods with a quasi-experimental research design. This quantitative method is designed to ensure that the research carried out does not deviate from the research objectives. Experimental methods are usually applied in research to see the effects of treatment. The design in this study used a control group pretest-posttest design, namely by conducting pretest and posttest in both classes. Data collection on student learning outcomes was carried out by providing an electro-pneumatic practical learning model based on Troubleshooting in the experimental class. The control class does not use an electro-pneumatic practical learning model based on Troubleshooting. The dependent variable is the learning outcomes based on creativity in students, while the control variable is the two classes that have the same teacher with the same material in each class.

The study program in the mechanical engineering department is Mechanical Engineering Education (MEE) S1, Mechanical Engineering (me) S1 students, and Automotive Engineering Education (AEE) which consists of 7 classes. The researcher used the subject of the AEE S1 2017 students, which consisted of two classes; the two classes were chosen because they carried out the Hydraulic Pneumatics course in the 2020/2021 odd semester. In determining the number of samples, the researcher used the slovin method with a tolerance of difficulty $\alpha = 5\%$. With the number of students in the class collected as many as 70 students, it can be concluded that the research sample conducted in this study was 60 students. Calculation of sampling using proportionate stratified random sampling technique with the results of each class consisting of 30 people. Samples were selected randomly/random sampling. Based on this technique, AEE S1 class 1 becomes the experimental class and AEE S1 class 2 becomes the control class.

Several data were collected, including students 'initial electro-pneumatic in the form of pretest scores and students' electro-pneumatic creativity abilities in the form of posttest scores. This learning outcome test instrument is in the psychomotor domain that explores students' creativity. This value is used in analyzing the treatment results that will be applied in the learning process. This test gives a multiple choice question consisting of four answer options. Questions are also arranged in such a way that they can find out the results of the practical learning that has been given.

Before the two groups were given treatment, both groups were given a pretest. The initial test is useful in observing the initial abilities of the experimental group who will be given a Troubleshooting-based practical learning model and the control group that does not use the Troubleshooting learning model. It is hoped that from the pretest conducted in both groups, it can be concluded that the two groups have the same initial ability. In knowing the difference in the initial ability of the two groups, the t-test can be used.

After the treatment was given to the experimental and control groups, a test was carried out to retrieve value data in the experimental and control groups. The values obtained from the data were analyzed and compared to find the higher results between the experimental and control groups through hypothesis testing. Hypothesis testing is the last stage of research. Hypothesis testing will analyze the data that has been obtained from both classes after being given treatment. If the test results are normally distributed and homogeneous, then the next step is to test the hypothesis. In testing, a proposed hypothesis can use a t-test.

Internal validity comes from the implementation of the research itself, which is related to the treatment given and whether it causes the results observed in the study. Some of the things contained in the internal validity that can be a threat in this study are as follows. History is an event that occurred in the vicinity or environment at the same time that the experimental variable was carried out through testing. Judging from the history of class formation in the control and

experimental groups, it was not specifically formed. Thus, the experimental and control group students had the same learning experience.

Maturity refers to the process of change that occurs in the subject who is made into the experimental group. To overcome this, research is carried out using the same time period for the experimental group and the control group so that they will have the same experience of maturity. The time period used was six to six meetings to conduct treatment in the experimental group and the control group, in addition to the use of the control group, which had students of the same age as the experimental group. So, the conclusion of this research is free from the threat of maturity factor. Subject's attitude in research, the subject may realize that he is a participant in the experiment, so a feeling of pride arises because someone is paying attention, let alone it is known that this research is to improve the condition of the subject. In this study, the attitude of the subject can be overcome by seeking students to assume that this research is a routine matter, and in this study, the teacher is the teacher himself so that students do not cause excessive reactions or attitudes.

In addition to internal factors, other external factors have an influence on research results, namely external validity. External validity refers to generalization and regarding how far we can generalize research results outside the research setting. The threat of external validity that needs to be considered and how to overcome it in this study is the interaction between subject selection and treatment. Talking about the relationship that occurs can be generalized to the category of subjects that can be a threat to high external validity. It is necessary to consider the subject's characteristics with the treatment given. In this study, members were selected randomly (randomly) to determine the sample to obtain a representative sample of the population. The sampling technique used in this study is the Random Sampling technique by drawing lots on the population that has been formed in classes so that each class in the population has the same opportunity to be used as a research sample.

RESULT AND DISCUSSION

Before being given a treatment for each class, their initial abilities were analyzed first. The initial ability analysis process is based on the pretest score in each class. The following are the results of the student pretest which can be presented in Table 2.

Table 2. Pretest Mean Value and Standard Deviation

Class	Number of Students	Mean Score	Standard Deviation
Experiment	30	76,26	11,97
Control	30	74,53	10,31

Table 2 shows the pretest average for the experimental class of 76.26 with a standard deviation of 11.97. The pretest score for the control class is 74.53, and the standard deviation is 10.31. The table above shows that the pretest average value of the experimental class is relatively higher. In accordance with the results of the t-test on the pretest, the value of t_{count} 1.346 < t_{table} 1.67 at $\alpha = 5\%$ with DK = 58.

Table 3. Pretest Data Similarity Test Results

Group	Mean	t_{count}	t_{table}	Criteria
Experiment	76,26	0,6	1,67	No different
Control	74,53			

Table 3 shows that each class has the same initial abilities. Therefore, the pretest score can be a reference in knowing that the different posttest scores later are purely from treatment and not from different conditions from the start in each class. Furthermore, a posttest was carried out for analysis in further research. The following are the results of the post-test in each class which is presented in Table 4.

Table 4. Posttest Mean Value and Standard Deviation

Class	Number of Student	Mean Score	Standard Deviation
Experiment	30	77,5	7,62
Control	30	64	8,84

In table 4, the post-test result in the experimental class after applying the troubleshooting-based electro-pneumatic practice learning model is 77.5, with a standard deviation of 7.62. After implementing electro-pneumatic learning but not using the troubleshooting model, the post-test results for the control class were 64, with a standard deviation of 8.84. The post-test results, according to table 4, show that the post-test scores of the experimental class are higher.

The Chi-square formula in this study is applied to determine the normality of the data. The data is declared normal if the significance value is higher than the error level of 5% or 0.05 at DK 30 - 1 = 29. The following are the results of the normality test in learning electro-pneumatic practice, both from the pretest and post-test data in each class which is presented in Table 5.

Table 5. Data Normality Test Results for Experiment Group and Control Group

Data Source		$X^2{}_{count}$	$X^2{}_{table}$	Criteria
Pretest	Exp	29,86	42,6	Normal
	Control	33,59	42,6	Normal
Postest	Exp	18,02	42,6	Normal
	Control	6,25	42,6	Normal

In the normality test, the pretest and post-test values of the two classes are summarized in table 5 above, explaining that the learning outcome data is normally distributed because the X value is less than the X table for α = 5% with DK = 29. Next is the hypothesis test that can be used with the F Test formula. The F test is applied to test the homogeneity of this study. The pretest and post-test data criteria are homogeneous if the data has a significance level higher than the error level of 5% or 0.05. If the data is homogeneous, do the t-test, but if the pretest and post-test data criteria are not homogeneous, the t-test cannot be used. After the homogeneity test was carried out on the electro-pneumatic practice values, both pretest and post-test, the values obtained are presented in Table 6.

Table 6. Data Homogeneity Test Results

Data Source		F_{count}	F_{table}	Criteria
Pretest	Exp Control	1,346	1,85	Homogeneous
Postest	Exp Control	1,345	1,85	Homogeneous

Table 6 above shows that after the homogeneity test of the data with the F test was carried out, the results obtained were that the value was less than 1.85 at α = 5% and DK = 58. Therefore, it can be concluded that the pretest and post-test data in both classes are homogeneous, so the t-test can be performed. Based on the normality test presented, the data from the pretest and post-test in the experimental class and control class were normally distributed, and the homogeneity test presented gave the data results from the pretest and post-test in the experimental class and control class with the homogeneous distribution. Therefore, in testing the hypothesis in this study using parametric statistics. The condition for using parametric statistics is that we can determine that the distribution we observe has met the normal distribution. The results of the t-test to test the hypothesis on the learning outcomes of electro-pneumatic practice in the two classes are presented in Table 7.

Based on the t-test on the learning outcomes of electro-pneumatic practice in both classes, the value of t_{count} 6.335 > t_{table} 1.67 at α = 5% with DK = 58. Therefore it can be stated that the learning outcomes of students in electro-pneumatic practice by applying the troubleshooting learning model experienced a significant increase compared to the learning outcomes of students who took electro-pneumatic practical learning without applying the troubleshooting learning model.

Table 7. Difference Test Results in the Experiment Group and the Control Group

Group	Mean	t_{count}	t_{table}	Criteria
Experiment	77,5	6,335	1,67	Significant
Control	64			

Table 7 illustrates that the value of troubleshooting-based electro-pneumatic practice learning in the experimental class is higher than in the control class. One of the successes in this learning is due to the use of the appropriate learning model according to the conditions and learning objectives. This is because the learning model is a system that is applied in creating a curriculum (learning plan), compiling materials for the learning process, and guiding the learning process in class or other learning spheres (Rusman, 2014).

The use of this troubleshooting-based electro-pneumatic practice learning model allows students to develop creativity in problem-solving systematically so that students' creativity can be developed through an understanding of solving problems. Therefore we need encouragement in an environment that is based on the creative potential that exists in each person. Then, between environmental factors and the potential for creativity, collaboration is needed so that the development of individual creativity will accelerate through cognitive skills. Creativity is the result of learning cognitive skills so that creativity can be learned (Slameto, 2015). The characteristics of creativity are divided into two categories, namely cognitive and non-cognitive. Cognitive characteristics include originality, flexibility, fluency, and sophistication (Slameto, 2015). Meanwhile, non-cognitive characteristics include motivation, attitude, and personality creativity. These two characteristics are important in learning. Intelligence, if not supported by creativity, cannot create something. Creativity can be born from intelligent people with good mental conditions. Creativity is not only about the brain's ability but also the emotional and mental health variables that influence the creation of creative work. Without common sense, it will be difficult to create creative work.

Iskandar's (2015) research stated that there are differences in troubleshooting learning in the automotive expertise program that already exists, and the development of learning models is carried out. The research results are: (1.) In accordance with the quantitative research method, it is known that the total post-test score of the experimental group is higher than the total score of the control group, so the development of this learning model can significantly improve learning outcomes in improving skills; and (2.) The use of this Troubleshooting learning model can be applied and in accordance with the 21st century and is proven to be effective in improving the skills of students, and creativity is a useful basis for the world of work. After implementing this model, it is hoped that SMK graduates will be able to increase their competitiveness at the ASEAN level to welcome the ASEAN Economic Community (AEC) and AFLA in 2020 and be able throughout the world in 2000 to meet global needs.

Damayanti's et al., (2020) research stated that there are differences between students when applying the PBLFC model, PTFC model, and DI model in physics lessons. The PBLFC learning model has a better level of creativity than the class that applies the PTFC learning model. At the same time, the class that uses the PBLFC learning model has better creativity than the class that applies the DI learning model. And the class that uses the PTFC learning model has better creativity than the class that uses the DI learning model.

The pre-test results show that both classes have the same initial ability, so the same initial ability in the two classes qualifies for further research. The successful use of the troubleshooting-based practical learning model has been proven from the post-test mean score of the experimental class higher than the practical learning without using the troubleshooting model in the control class. So, the application of this troubleshooting learning model can be used as a learning model solution for teachers during the learning process. Conversely, lower control class post-test results can occur because students feel that learning tends to be monotonous and that there is a lack of a learning system that can sharpen the brain and increase students' creativity. The t-test analysis that has been carried out on the post-test scores shows an increase in learning outcomes that comes from the treatment and does not occur because of different initial conditions because the initial abilities of the two classes have different criteria.

The application of troubleshooting-based electro-pneumatic practice learning models has a significant impact on increasing the creativity of students. The dimensions of creativity used in this research instrument are fluency, flexibility, originality, and elaboration. Creativity is the interaction between each individual towards the environment based on data, communication, or previously known elements from the family, school, or community environment (Munandar, 2009). Trouble-shooting learning models are usually applied to train skills in repairing problematic products or systems by searching logically and systematically for the source of the problem to get a solution to solve it. Troubleshooting is expected to increase creativity because it can train psychomotor skills in students.

In addition, this research was carried out during the Covid-19 Pandemic, where learning was implemented using an online system. The method of learning with an online system or online is a learning system in which the implementation process is not carried out face-to-face but is carried out using the internet network. Therefore, the learning process must continue with a switch of methods very different from pre-pandemic learning methods, namely face-to-face learning methods replaced with online ones. So, students do not get practical experience directly using practice props. The learning process of troubleshooting practice is carried out in a simulation application, where the process of giving problems to the circuit is carried out by combining changing component symbols, changing the direction of the circuit, and replacing several processes that occur in a series. Therefore, the ability to think and creativity of students can be honed in the process of finding a problem and finding a solution to the problem so that the system in the electro-pneumatic circuit normally runs again. In addition to honing students' thinking skills, this learning model can increase students' enthusiasm for the learning process.

Troubleshooting learning models can be applied in electro-pneumatic competencies. As a problem-solving model, troubleshooting has two main models: design and implementation. The model design focuses more on designing activities related to several factors and teaching steps to be applied. Using troubleshooting-based practical learning models can increase students' creativity and positively contribute. This is evidenced by the t-test analysis on the pre-test and post-test in both classes so that it can be a solution for other educators in implementing similar practical learning to develop creativity in students, especially if learning is still using an online system (Iskandar, 2015).

CONCLUSION

According to the results of the research and discussion, the researcher can conclude that there is an increase in learning outcomes in the experimental class by applying a troubleshooting-based practical learning model compared to the control class, which does not apply the troubleshooting learning model in electro-pneumatic practice. This statement can be proven from the post-test scores in the experimental class with the application of the troubleshooting-based electro-pneumatic practice learning model with an average score of 77.5, better than the post-test learning outcomes in the control class with an average score of 64 so that the troubleshooting-based electro-pneumatic practice learning method is feasible to use, especially during a pandemic that requires learning to be carried out online.

Based on the findings that have been discussed, the suggestions given by the researcher are: First, educators are advised to use various learning models that are in accordance with the material and objectives presented, which can be a good stimulus for the learning process. In particular, electro-pneumatic learning can use problem-solving practice learning models. Second, further researchers who are interested in the topic of problem-solving learning models in providing systematic problems can be done in stages. The creativity of students in the classroom that uses the Troubleshooting-based practical learning method is higher than in the Classroom Learning Outcomes that do not use the Troubleshooting-based practical learning method. So, this troubleshooting-based electro-pneumatic practice learning method affects increasing student learning outcomes.

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