Jurnal Pendidikan Vokasi
Volume 7, No 3, November 2017 (329-339)
Online: http://journal.uny.ac.id/index.php/jpv

DEVELOPING CONVEYOR TRAINER KIT FOR PROGRAMMABLE LOGIC CONTROLLERS IN PRACTICAL LEARNING

Sukir
Yogyakarta State University
sukir@uny.ac.id

Soenarto
Yogyakarta State University
soenarto@uny.ac.id

Soeharto
Yogyakarta State University
hart_harto@yahoo.co.id

Abstract

The research aims: (1) to produce conveyor trainer kit equipped with a monitoring system along with its work performance, (2) to know the appropriateness and effectiveness of the use of conveyor trainer kit and module of PLC practical learning. This study is a development research using ADDIE model based on Branch, RB. The steps of this study are: analysis, designing, developing, implementation, and evaluation. Data collection is conducted through observation, survey, and test by using the instruments: observation sheets, questionnaire, and examination. The data are analyzed descriptively using nonparametric test of difference by Mann Whitney. The finding shows: (1) the product of conveyor trainer kit equipped with monitoring system has good work performance; (2) conveyor trainer kit and the module are very appropriate, and the implementation of conveyor trainer kit and module of PLC practical learning can improve student learning outcomes in cognitive, psychomotor, and affective aspects effectively.

Keywords: *trainer kit, conveyor, programmable logic controllers.*

INTRODUCTION

The knowledge and technology development applied in the industry recently is advanced. One of the advancement in electrification is the use of Programmable Logic Controllers (PLC) as the brain controller of many machine equipment in the industry. The example of equipment or industry media controlled by PLC is conveyor machine, now developed with a monitoring system using Human Machine Interface. Most industries have the conveyor to bring the production of goods from one place to another with specific work process. The use of conveyor equipped with a monitoring system and controlled by PLC is more excellent than that of without a monitoring system. When there is a problem with conveyor control, it will be directly detected through the monitor so the problem can be solved quickly.

Related to the development of the use of PLC as conveyor controller and other machines in industries, Vocational High Schools, especially on the competencies of Electrical Installation Engineering, are forced to equip their students with PLC competencies. PLC competencies are essential to students to be familiar to handle jobs related to the use of PLC as technology advancement in industries. It supports the competencies profile of Vocational High School of Electrical Installation Engineering that is to create competent labors as the electric technician who can: (1) design and install lighting and electric power; (2) assemble industrial machinery control panel, including PLC control; and (3) maintain and improve various electrical equipment.

Based on the initial observation conducted in SMK Negeri 1 Sedayu, Bantul, SMK Negeri 2 Pengasih, Kulonprogo, and SMK Negeri 2 Wonosari, Gunungkidul, the data shows that in the implementation of Curriculum 2006, PLC competencies are taught to XI grade of the fourth semester in the form of PLC practical learning on the subject of Assembly and Control System Operation. In Curriculum 2013, PLC competencies are taught in the form of PLC practical learning on the subject of Installation of Electric Motors in the XII grade of the fifth semester. PLC practical learning, which refers to Curriculum 2013, has been implemented from the fifth-semester academic year 2016/2017; however, not all Vocational Schools in Yogyakarta have implemented Curriculum 2013, and there are some other Vocational Schools that still implement Curriculum 2006. Basically, the basic competencies of PLC on both curricula are not really different.

According to the initial observation conducted in those three Vocational High Schools, the data shows that PLC practical learning on the subject of Assembly and Operation Control System, and the competencies of PLC practical learning achieved by the students are still poor. The result can be seen in the data of the students learning outcomes in those schools. In the academic year 2010/2011 and 2012/2013, the average number of students who achieved PLC competencies score of 70 or more are still under 50%. The other data also shows that all PLC practical equipment is only available in separate basic blocks to practice abstract control simulation. The schools do not have practical equipment in the form of trainer kit for industry machine or miniature of industrial equipment which can be operated for real by using PLC controller. Based on the interviews conducted to students during the initial observation of those schools, it can be concluded that because the practical equipment used at school is still abstract and simulative, the students are less interested, less enthusiastic, less motivated, and have less understanding in following PLC practical learning.

Based on the previous description, it is necessary to research media development in the form of practical equipment like small trainer kit of the industrial machine, especially the conveyor that can be operated in real with PLC controller. The development of conveyor trainer kit should be upgraded to the newest technology that is monitoring system control using Human Machine Interface (HMI). To make the learning easy, the module of PLC practical learning is created and Vocational High School of Electrical installation engineering use it.

Rauner, Maclean, Pabst, & Zimmer (2008, p. 569) states that there are three types of learning media based on its form: real thing, model, and simulation. Media in the real thing or simulation can be created in the kind of trainer kit. Trainer kit as a learning media consists of the equipment or simulation, and the explanation of the user is on the job sheet or the learning module.

One of the examples of industrial equipment developed as trainer kit is a conveyor. According to Naseer (2009, p. 2), a conveyor is a unit of equipment to move the production of goods from one place to another in the industry by using a specific working system. Conveyor trainer kit developed in this research is equipped with a monitoring system using Human Machine Interface (HMI). According to Hidayat & Sumardi (2013, p. 1), HMI is an interface or display connecting human and machine. PLC then control the conveyor trainer kit equipped with the monitoring system. Zimmerman (2008, p. 23) states that PLC is a digital electronic instrument using the integrated structure with memories that can be programmed as an internal storage of groups of instruction, by implementing the function of logical, sequential, timing, counting, and arithmetic to apply control function.

Furthermore, Rauner, Maclean, Pabst, & Zimmer (2008, p. 569) explain that the use of media in learning influences student learning outcomes and learning experience as presented in Edgar Dale’s cone of experience. Based on it, the learning experience lies from top to bottom, which shows that the learning experience starts from abstract to concrete. The learning experiences are through: verbal, symbol, visual, radio, film, television, exhibition, study tour, demonstration, drama, simulation, and real experience. The use of learning media which is more concrete may simplify student understanding of the learning material. Conveyor trainer kit developed in this research belongs to Edgar Dale's cone of experience that is learning the lesson through simulation. It means that conveyor trainer kit can bring student learning experience to the concrete one. Therefore, the student can quickly master the competencies.

The related research on conveyor trainer kit is conducted by Gill, Kumar & Kumar (2015, p. 66) entitled “*Designing and fabrication of electro-pneumatic trainer kit*” which produces electro-pneumatic trainer kit for learning in Mechanical Engineering Majors, Gulzar Group of Institutes, India. Jamaluddin, Ghani, Rahman, & Deros (2014, p. 24) conducts the research about "*Development of training kit for learning Taguchi method and design of experiments*", which shows that Taguchi experiment has been successfully conducted through the trainer kit, and the tested factorial design is basically appropriate to the information gained from Taguchi method. Samanol, Hamid, & Ramli (2014, p. 182) also research “*Development of pneumatic trainer kit for a polytechnic student*," which produces pneumatic trainer kit of basics of pneumatic learning for students majoring in Machine, Politeknik Seberang Perai, Malaysia. Sean (2015, p. 4) conducts a research about "*BeRobot-the robotic scientific education development kits*," which produces trainer kit in the form of the human-like robot called BeRobot, used as training equipment for those who work and interested in a robot.

The other research related to the development of the learning module to support the use of conveyor trainer kit is conducted by Hamid, Ariwibowo, & Desmira (2017, p.149) about *“Development of Learning Modules of Basic Electronics-Based Problem-Solving in Vocational Secondary School.*” The research results the problem solving-based learning module on the Basic Electronics subject which is appropriate to be used in Vocational Secondary School. Other similar research is also conducted by Fatkhurrokhman, Permata, Ekawati, & Rizal (2017, p. 101) about *“The Teaching Devices Development of Digital Engineering Using Project Based Learning in Department of Electrical Engineering Education”.* The research results lesson plans and project-based practical module on the Digital Engineering subject which fulfill the criteria on its validity, practice, and effectivity to be used in the Department of Electrical Engineering Education, Faculty of Teaching and Education, University of Sultan Ageng Tirtayasa.

The difference between this research and the research mentioned previously lies in the type, work function, performance, and the use of trainer kit for learning in the different majors, study programs, skill competencies, and educational levels. Besides that, the learning approach used in developing the learning module is also different. If there is other research about developing conveyor trainer kit, it would be different from this research. This research is a product development in the form of conveyor trainer kit equipped with a monitoring system using HMI implemented in PLC practical learning in Vocational High School of Electrical Installation Engineering.

The other different thing about this research is that it also implements student-centered learning in developing the learning module to support the use of conveyor trainer kit.

This research aims to produce conveyor trainer kit equipped with a monitoring system along with its performance category used in PLC practical learning in Vocational High School. This study also aims at knowing the appropriateness level of conveyor trainer kit and its module used in PLC practical learning in Vocational High School. Besides that, this research is to see the effectiveness of the handling of conveyor trainer kit equipped with a monitoring system and module for PLC practical learning in Vocational High School.

The benefit of this research to the students is that it can bring the modern atmosphere of learning. Therefore, the students will be more enthusiastic and motivated, and the learning becomes more meaningful. This research also increases the students' PLC competencies. The product development of conveyor trainer kit and PLC practical learning module can help teachers' tasks as the learning facilitator and also improve students' motivation, enthusiasm, and attention.

RESEARCH METHOD

The type of this research is research and development which refers to the ADDIE development model according to Robert Maribe Branch. The steps of this study are: (1) analyzing and conducting need analysis in nine Vocational High Schools in Yogyakarta, and the result was evaluated and revised; (2) designing the conveyor trainer kit equipped with a monitoring system and the module of PLC practical learning, and the result was evaluated and reviewed; (3) developing conveyor trainer kit equipped with the monitoring system and module of PLC practical learning, and the result was validated and reviewed by teachers and experts; (4) implementing the test/trial of conveyor trainer kit equipped with a monitoring system and module of PLC practical learning in Vocational High Schools, and it was evaluated and reviewed, therefore the final product of conveyor trainer kit and PLC practical learning module were ready.

Validation of the product of conveyor trainer kit and learning module was conducted by two material experts, two media experts, and four teachers in a Focus Group Discussion. The trial implementation of conveyor trainer kit product and learning module in Vocational High Schools was conducted by using a quasi-experimental design in the form of pretest-posttest nonequivalent control group design. The data collection techniques used were through observation, survey, and test with the instruments in the form of observation sheets, questionnaire, and examination. Instrument validity was decided by using face validity and content validity through expert judgment. Instrument reliability was in the form of questionnaire and observation sheets which the number of respondents decided through reliability coefficient counting using Alfa of Cronbach formula. Instrument reliability in the form of observation sheets used by two observers was decided by using a coefficient of the agreement by Scott. The data were analyzed descriptively and to know the effectiveness of the handling of conveyor trainer kit and learning module and the obtained data were analyzed by using Mann Whitney and Wilcoxon's nonparametric test of difference with the significance rate of 0,05.

FINDING AND DISCUSSION

The first step of the research is conducting need analysis. The prominent need analysis results based on the teachers and students in PLC practical learning in nine Vocational High Schools in Yogyakarta can be summarized in Table 1. The result of the need analysis is evaluated by a material expert and a teacher who approve the conveyor trainer kit development equipped with a monitoring system and learning module. Based on the previous statement, it is expected that students' participation and characteristic can be better. However, the two evaluators suggest that the monitoring system given should be from the basic because the students who are going to use it are those who study high tension current of electricity.

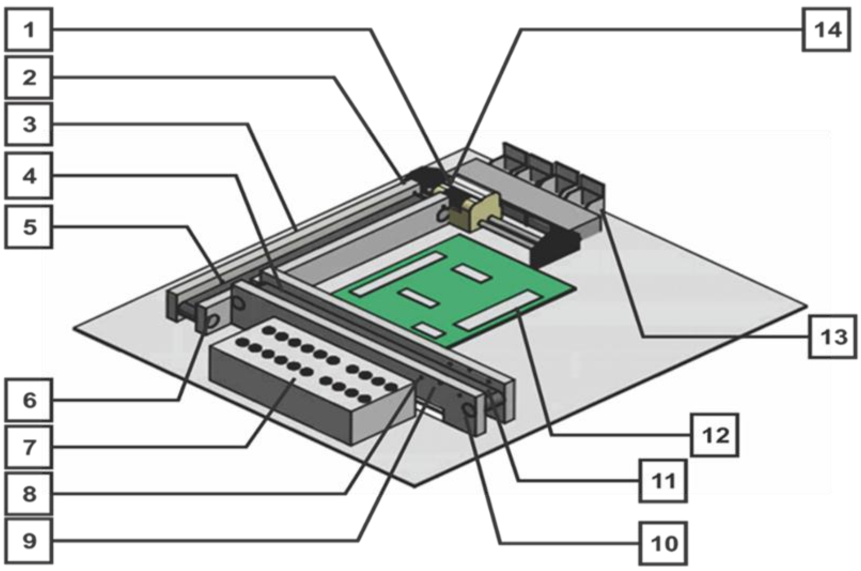
The second step of the research is designing conveyor trainer kit equipped with a maunitoring system and module of PLC practical learning which refers to the revision of need analysis results. The design of the trainer kit prototype is presented in Picture 1. The result of the design of conveyor trainer kit is evaluated by a material expert and a teacher who approves the design of conveyor trainer kit without any revision.

The third step of the research is making of conveyor trainer kit equipped with a monitoring system and module of PLC practical learning. The result of the conveyor trainer kit equipped with monitoring system is presented in Picture 2. Evaluation towards the product of conveyor trainer kit equipped with a monitoring system and learning module is conducted through validation process which involves the material experts, the media experts, and the teachers. The result of material experts' validation toward the performance of conveor trainer kit equipped with a monitoring system is presented in Table 2.

The result of the material experts, media experts, and teachers' validation toward the appropriateness of conveyor trainer kit equipped with a monitoring system product is presented in Table 3. The result of the material experts, media experts, and teachers' validation toward the appropriateness of PLC practical learning module is presented in Table 4. The suggestion given by experts and teachers toward the product of conveyor trainer kit is that the writing of INPUT and OUTPUT should be enlarged, while to the module, it is suggested to clarify the unclear pictures and to put the answers at the end of the module.

Table 1. The Results of Prominent Need Analysis of PLC Practical Learning in Vocational High Schools

Number	Indicator	Average Value (%)	Category
1.	Student characteristics (ease of learning, basic provisions of control, and mastery of competencies).	51,97	Poor
2.	Student participation in learning (enthusiasm, motivation, activeness, and independence).	56,17	Poor
3.	Trainer kit needs (conveyor trainer kit equipped with the monitoring system and module).	99,29	Strongly needed
4.	Trainer kit criteria (based on basic competencies, easy to use, made of local, and refers to the work safety).	99,27	Strongly approved



Information: (1) sensor sorting (S6); (2) final sensor (S5); (3) conveyor B; (4) conveyor A; (5) conveyor B sensor (S4); (6) motor B (MB); (7) jumper connector; (8) color sensor (S3); (9) altitude sensor (S2); (10) motor A (MA); (11) object sensor(S1); (12) elektronic circuit; (13) objects container; and (14) motor discs.

Figure 1. The design of conveyor trainer kit prototype

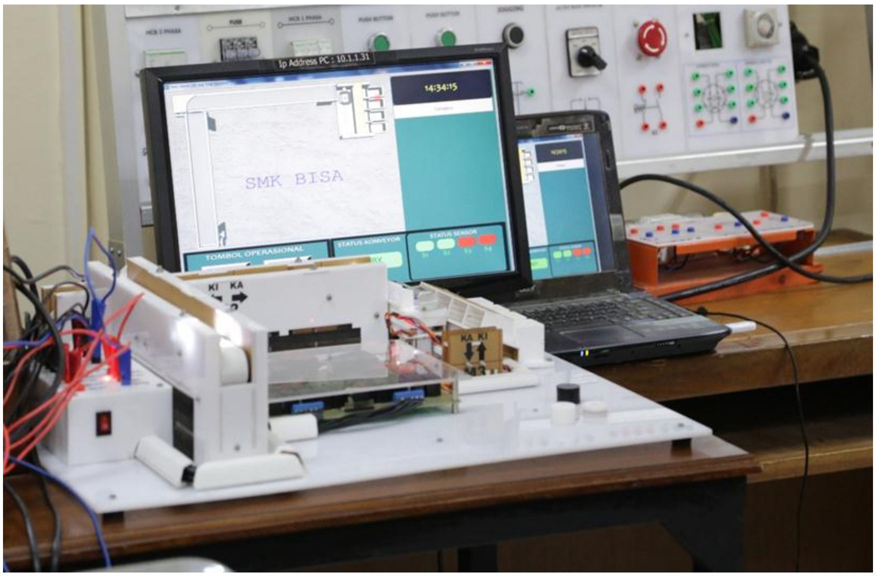


Figure 2. Conveyor Trainer Kit Equipped with a Monitoring System

Table 2. The Results of Material Expert Validation towards Conveyor Trainer Kit Performance

Number	Performance	Value (%)	Category
1.	If the thin black object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into the container I.	100	Very good
2.	The process of moving and placing the thin black object is displayed on the monitor.	75	Good
3.	If the thick black object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into container II.	100	Very good
4.	The process of moving and placing the thick black object is displayed on the monitor.	75	Good
5.	If the thin white object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into container III.	100	Very good
6.	The process of moving and placing the thin white object is displayed on the monitor.	75	Good
7.	If the thick white object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into container IV.	100	Very good
8.	The process of moving and placing the thick white object is displayed on the monitor.	75	Good
9.	Stop operation can stop the conveyor after the working cycle/process has done.	100	Very good
10.	The emergency operation can stop the working process of conveyor instantly.	100	Very good
11.	Reset operation can restart the working system of the conveyor on standby position.	100	Very good
	The total value	90,91	Very good

Table 3. The Results of Material Experts, Media Experts, and Teachers' Validation towards the Appropriateness of Conveyor Trainer Kit

No	Aspects	Material Experts		Media Experts		Teachers	
		Value (%)	Category	Value (%)	Category	Value (%)	Category
1.	Relevance	100,00	Very appropriate	97,92	Very appropriate	95,83	Very appropriate
2.	Benefit	100,00	Very appropriate	90,91	Very appropriate	94,23	Very appropriate
3.	Material	97,92	Very appropriate	78,13	Appropriate	76,56	Appropriate
4.	Physical Prototype	78,57	Appropriate	92,86	Very appropriate	80,36	Appropriate
5.	Technique	82,14	Very appropriate	95,83	Very appropriate	81,25	Very appropriate
	Whole aspects	90,42	Very appropriate	91,91	Very appropriate	87,67	Very appropriate

Table 4. Results of Material Experts, Media Experts, ad Teachers' Validation towards the Appropriateness of PLC Practical Learning Module

No	Aspects	Material Experts		Media Experts		Teachers	
		Value (%)	Category	Value (%)	Category	Value (%)	Category
1.	*Goal-centered*	97,73	Very appropriate	90,00	Very appropriate	87,50	Very appropriate
2.	*Learned-centered*	78,13	Appropriate	73,33	Appropriate	88,28	Very appropriate
3.	*Contex-centered*	67,50	Appropriate	82,95	Very appropriate	69,89	Appropriate
4.	*Learning-centered*	68,75	Appropriate	84,38	Very appropriate	76,56	Appropriate
5.	Whole aspects	80,30	Appropriate	80,00	Appropriate	80,27	Appropriate

The fourth step of this research is implementing trials of conveyor trainer kit equipped with a monitoring system and learning module in SMKN 2 Pengasih. The trial design used is quasi-experimental design in the form of pretest-posttest nonequivalent group design. The experiment class is the class of TIPTL XII 1 which consists of 16 students who follow PLC practical learning using conveyor trainer kit equipped with a monitoring system and learning module. As the control class is the class of TIPTL XII 2 which consists of 16 students who follow the PLC practical learning using PLC simulation unit that applied in SMK at the moment.

PLC practical learning is conducted for fifty hours, or ten hours every week for five weeks, from October 10th to November 7th, 2016. The evaluation implemented in the trial of conveyor trainer kit equipped with a monitoring system and module of PLC practical learning are pretest, cognitive, affective assessment, cognitive posttest, and practical test in both experimental and control class. The result gained from the evaluation are in the form of the cognitive pretest value, affective value, cognitive posttest value, and psychomotor value achieved by the students in both experimental and control class. Next, the test of difference is conducted to the cognitive pretest value, affective value, cognitive posttest value, and psychomotor value achieved by students in both experimental and control class using Mann Whitney's nonparametric statistic test with the help of SPSS 17.0 program. The test of the difference between the value of cognitive pretest and value of cognitive posttest achieved by students in experimental class is conducted by using Wilcoxon's nonparametric statistic test with the help of SPSS 17.00 program. The test of difference is conducted by using no parametric statistic test because the numbers of the sample in quasi-experimental design are relatively small that is only 16 students, so the data tends to be abnormal and not homogenous.

Based on the test of the difference between the pretest value gained by students of experimental class and control class, significance value Asymp. Sig (2-tailed)=0.787 is higher than significance rate of 0.05. It shows that there is no significant difference between the average value of cognitive pretest achieved by students of experimental class and control class in PLC practical learning. It also means that students of experimental class and control class have the same early cognitive ability of PLC learning before they take PLC practical learning.

Based on the test of difference between the value of cognitive posttest achieved by students of experimental class and control class, the significance value of Asymp. Sig (2-tailed)= 0.023 is lower than significance rate of 0.05. It proves that it is significantly different between the average value of cognitive posttest achieved by students of experimental class and control class in PLC practical learning. In shorts, the implementation of conveyor trainer kit equipped with a monitoring system and module in PLC practical learning can efficiently improve students' cognitive value.

Based on the test of difference between psychomotor value achieved by students' of experimental class and control class, significance value of Asymp. Sig (2-tailed) =0.007 is lower than significance rate of 0.05. It shows that there is the significant difference between the average value of psychomotor achieved by students of experimental class and control class in PLC practical learning. It means that the implementation of conveyor trainer kit equipped with a monitoring system and learning module in PLC practical learning can improve the psychomotor value of the students.

Based on the test of difference between the affective value achieved by students of experimental class and control class, significance value Asymp. Sig (2-tailed) = 0.039) is lower than significance rate of 0.05. It shows that there is a significant difference between the average affective value of students of experimental class and control class in PLC practical learning. It means that the implementation of conveyor trainer kit equipped with a monitoring system and learning module in PLC practical learning can improve the affective value of the students.

Based on the test of difference of cognitive pretest and cognitive posttest achieved by students of experimental class and control class, significance value of Asymp Sig (2-tailed) = 0.000 is lower than the significance rate of 0.05. It shows there is a significant difference between the average value of cognitive pretest and cognitive posttest achieved by students of the experimental class. Next, in the score counting/ *gain (g)*, the score of 0,6139 is in the medium category. The counting results between the test of difference and *gain*, support the result of the test of difference of the average value of cognitive posttest achieved by students of experimental class and control class. Therefore, the implementation of conveyor trainer kit equipped with monitoring system and module in PLC practical learning can improve students' cognitive value effectively.

In the last activity of the trial of conveyor trainer kit equipped with a monitoring system and PLC learning module, two teachers and 16 students of the experimental class are asked to assess the product. Based on the assessment, the value for the whole aspects of 89.93% belongs to the very appropriate category. On the teachers' assessment to PLC practical learning module, the value of 80.86% belongs to the appropriate category. Based on the students' assessment toward conveyor trainer kit, the value of 86.50% belongs to a very appropriate category, while on the students' assessment towards PLC practical learning module, the value of 81.03% belongs to the appropriate category. Besides that, the teachers also suggest that on the input and output terminal of conveyor trainer kit need to be fastened and also there are pictures and tables in the module of PLC practical learning which have not been numbered and named, so it should be rewritten.

After the need analysis, designing, making, trial, and revision is conducted, then the conveyor trainer kit equipped with a monitoring system and module of PLC practical learning is finally completed. The produced conveyor trainer kit lies on the base made of acrylic with the length of 61 cm and 50 cm wide, the thick is 1 cm, and each has a pillar with the height of 1 cm. The central part of conveyor trainer kit consists of conveyor A and conveyor B which each has the length of 38 cm and 3 cm wide. Besides that, there is a rail of sorting with the length of 20 cm and 4,5 cm wide and four goods containers with the length of 3 cm and 3 cm wide. The main electricity component of conveyor trainer kit is the activator of conveyor A and conveyor

B, each of them are motor DC Gearbox 12 Volt, a motor of sorting carrier in the form of motor stepper 12 Volt DC, and motor booster in the form of motor servo DC 12 Volt. Electrical power needed is AC 220 Volt, and through the rectifier, the voltage of DC 12 Volt is produced. The other supporter components of the conveyor trainer kit are sensors, jumper connector, power supply circuit, monitor, and other supporting electronic components.

Based on the validation conducted by material expertise toward conveyor trainer kit, it gains the value of 90.01% which belongs to the very appropriate category. The performance of conveyor trainer kit is described as the following. If the thin black object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into container I. The process of moving and placing the thin black object is displayed on the monitor. If the thick black object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into container II. The process of moving and placing the thick black object is displayed on the monitor.

If the thin white object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into container III. The process of moving and placing the thin white object is displayed on the monitor. If the thick white object is in the starting position of conveyor A, then conveyor A moves the object to conveyor B, after that conveyor B moves the object to the sort discs, next the sort discs moves to place the object into container IV. The process of moving and placing the thick white object is displayed on the monitor. Stop operation can stop the conveyor after the working cycle/process has done, while emergency operation can stop the working process of conveyor instantly. Reset operation can restart the working system of a conveyor on standby position.

According to the result of the material experts, media experts, and teachers' validation toward conveyor trainer kit performance, it shows that the material experts give the value of 90,42%, the media experts give the value of 91,91%, and the teachers give the value of 87,67%, which belongs to the very appropriate category. Besides that, in the trial of conveyor trainer kit and PLC practical learning module, the teachers give the value of 89,93% which belongs to the very appropriate category, and the students give the value of 86,50% which also belongs to the very appropriate category. Based on the validation conducted by the experts of materials, the experts of media, and the teachers, and also the assessment conducted by the teachers and the students to the appropriateness of conveyor trainer kit as mentioned previously, the whole average value is of 89,29% which belongs to the very appropriate category. It means that conveyor trainer kit equipped with monitoring system meets the category of a very appropriate to be used in PLC practical learning in Vocational High School.

The new thing applied in this research is the development of conveyor trainer kit equipped with a monitoring system as it is recently applied in industry world. It surely gives the contribution toward the learning development in Vocational High Schools which use conveyor trainer kit equipped with a monitoring system in PLC practical learning. It also can give chance to students to get better learning experience which is similar to the technology development in industry world. Therefore the learning can be more meaningful.

Based on the validity conducted by the material experts, media experts, and teachers to PLC learning module, the material experts give the value of 80,30%, the media experts provide the value of 80%, and the teachers give the value of 80,27% which the three of the scores belongs to the appropriate category. On the trial of PLC practical learning module, the teachers give the value toward the module of 80,86% which belongs to the appropriate category, and the students give the value of 81,03% which belongs to appropriate category too. Based on the result of material experts, media experts, and teachers validation and the trial of PLC practical learning module applied by teachers and students, the average value is of 80,49% which belongs to the appropriate category. Therefore, it can be concluded that PLC practical learning module meets the appropriate category to be used in PLC practical learning in Vocational High School.

The result of the test of difference of cognitive pretest in the experimental and control class shows that there is no significant difference between the average value of cognitive achieved by students in the experimental class and control class in PLC practical learning. It means that students in both experiment and control class have the same cognitive ability in the early stage. It is because PLC practical learning in Installation of Electrical Motor subject in the fifth-semester is a new subject. Therefore students in the experimental and control class have the same early ability of cognitive, psychomotor, and affective.

Based on the test of difference of cognitive, psychomotor, and affective postest value achieved by students of experimental and control class, it shows that there is a significant difference between the average value of cognitive, psychomotor, and affective achieved by students of TIPTL 1 (experimental class) and TIPTL 2 (control class) in PLC practical learning. Besides that, on the test of difference of cognitive pretest value and cognitive postest value achieved by students of TIPTL (experimental class), it shows that there is a significant difference between the average value of cognitive pretest and the average value of cognitive posttest achieved by students of the experimental class. It means that the implementation of conveyor trainer kit equipped with the monitoring system and module in PLC practical learning can improve students' learning outcomes effectively especially in the cognitive, psychomotor, and affective aspects of PLC practical learning in Vocational High School.

This also supports the Cone of Experience theory by Edgar Dale as stated by Rauner, Maclean, Pabst, & Zimmer (2008, p.568), that the learning experiences stretches from top to bottom which shows that the learning experience starts from the abstract to concrete. The meaning of this statement is that the learning experience through the abstract media may produce the conceptual knowledge which is difficult to understand by students. On the contrary, the more concrete the media used, the more real the experience achieved by the students and they can quickly master the knowledge. Conveyor trainer kit equipped with a monitoring system is the miniature of industry equipment, therefore students gain more actual learning experience about PLC application in the industry. This also can make students' PLC practical learning easier, and then their learning outcomes may improve.

This research is also following the research related to trainer kit as conducted by Ranjit, Anas, Subramaniam, Tan, & Chuah (2012, p. 28), about the development of *solar educational trainer kit.* The research shows that solar educational trainer kit can simplify the user understanding of the concept of electrical charging and conversion of DC electrical power to AC electrical power. Other research conducted by Aras & Azis (2014, p. 1) about *Remotely Operated Vehicle (ROV) trainer kit for education purposes*, also produces the appropriate result as the following research, *Remotely Operated Vehicle (ROV) trainer kit* which gives the understanding about control system of underwater vehicle operated from far distance. This study also goes hand in hand with the research conducted by Hong, Hong, Samin, Sulaiman, & Khaksar (2013, p. 3304) who develop *educational robotic training kit*, which shows that the use of *educational robotic trainer kit* in learning can save the cost and simplify students understanding. However, the three types of research mentioned previously are different from this analysis. The object developed in this study is the different trainer kit. The previous three types of research are implemented in higher education like university while this study is applied in Vocational High Schools. Therefore the characteristics of the students are also different.

CONCLUSION

Conclusion gained from this research are: (1) the conveyor trainer kit equipped with a monitoring system for PLC practical learning in Vocational High School is produced and its performance is excellent and marked with the value of 90,91%; (2) conveyor trainer kit equipped with a monitoring system used in PLC practical learning is very appropriate and marked with the value of 89,29%, while the module is also suitable and marked with the amount of 80,49%; and (3) the implementation of conveyor trainer kit equipped with the monitoring system and module of PLC practical learning in Vocational High School can effectively improve students' learning outcomes in cognitive, psychomotor, and affective aspects.

Suggestion

Vocational school principals should provide conveyor trainer kit equipped with monitoring system and module of PLC practical learning in Vocational High School. It is also necessary to do so since the use of conveyor trainer kit equipped with monitoring system can give the real experience of learning primarily to control the miniature of industrial equipment. Therefore, the learning can be more efficient and meaningful. Besides that, since the use of PLC practical learning module is appropriate, the students should have the module independently, especially on the material of PLC programming for the learning material and for the practical tutorial in the laboratory. PLC practical teachers should have the module earlier and learn it independently so they can be well-prepared as the learning facilitators.

REFERENCES

Aras, M. S. M., & Azis, F. A. (2014). ROV trainer kit for education purposes. *International journal of science and research (IJSR)*, *3*(5).

Fatkhurrokhman, M., Permata, E., Ekawati, R., & Rizal, S. (2017). Pengembangan perangkat pembelajaran teknik digital berbasis project based learning di jurusan pendidikan teknik elektro. *Jurnal Pendidikan Vokasi, 7*(1), 101-109. doi:http://dx.doi.org/10.21831/jpv.v7i1.12547

Gill, K. J. S., Kumar, R., & Kumar, S. (2015). Designing and fabrication of electro-pneumatic trainer kit. *International Conference on Advanced Research and Innovation (ICARI-2015), India, p.59-66.*

Hamid, M., Aribowo, D., & Desmira, D. (2017). Development of learning modules of basic electronics-based problem solving in Vocational Secondary School. *Jurnal Pendidikan Vokasi*, *7*(2), 149-157. doi:http://dx.doi.org/10.21831/jpv.v7i2.12986

Hidayat, R. & Sumardi. (2013). Perancangan human machine interace (HMI) pada hitcut machine dengan PLC Omron Sysmac CPIL. Semarang: Universitas Diponegoro.

Hong, T. S., Hong, T. H., Samin, R., Sulaiman, S., & Khaksar, W. (2013). Development of an Educational Robotic Training Kit. *Advanced Science Letters, 19*(11), 3304-3306(3).

Jamaluddin, H., Ghani, J. A., Rahman, M. N. A., & Deros, B. M. (2014). Development of Training Kit for Learning Taguchi Method and Design of Experiments. *Jurnal Teknologi (Sciences & Engineering) 68*(4)*, 19–25.*

Naseer, M. (2009). *Best protection conveyor safety*. Cubee: Alberta.

Ranjit, S. S. S., Anas, S. A., Subramaniam, S.K., Tan, C.F., & Chuah, S.H. (2012). Development of solar educational trainer kit. *International journal of engineering and innovative technology (IJEIT), 2*(3).

Rauner, F., Maclean, R., Pabst, A., & Zimmer, G. (2008). *Handbook of technical and vocational education and training research.* Bremen: Springer Science Business Media.

Samanol, S. B., Hamid, S. B. A, & Ramli, M. N. B. (2014). Development of Pneumatic Trainer Kit For Polytechnic Student. *Journal of Mechanical Manufacturing (J-Mfac), 1. 178-183.*

Sean, C. (2015). BeRobot-The Robotic Scientific Education Development Kits. *Lovotics, an Open Access Journal,3*(1). *p. 1-4.*

Zimmerman, G. P. (2008). *Programmable logic controllers and ladder logic*. South Dakota: Department of Humanities South Dakota School of Mines and Technology.