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LEARNING PROCESS ANALYSIS BASED ON INDUSTRIAL PRODUCTS IN MECHANICAL PRACTICES

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Abstract

Revitalization of vocational education must be designed and developed according to the industry's needs through appropriate learning innovations. The selection of suitable learning methods influences the graduate competencies and learning experiences of students. This study aims to analyze the learning process based on industrial products in mechanical practices. The learning process analysis includes giving apperceptions and motivation, mastering learning materials, learning strategies implementation, learning resources or media, involving students, and closing the learning process. The research used an experimental method with a static group comparison design. This study used two groups consisting of the experimental and control group with 20 respondents for each. The experimental group is respondents who used industrial products-based learning, and the control group is respondents who used conventional learning (job sheet-based). The research respondents were students of the Mechanical Engineering Department Universitas Negeri Semarang who have passed the Mechanical Process I lesson chosen by random sampling technique. Research data were collected using a teaching and learning process questionnaire, while the data analysis technique used is the Mann Whitney U Test and descriptive statistics. The research findings show that there are differences in the process of the mechanical practice using industrial products-based learning and conventional learning (job sheet-based). Implementation of learning with the gift of apperception and motivation, mastery of learning materials, application of learning strategies, assembling of learning resources or learning media, students' participation in the learning process, and closing the learning process is better to use the industrial products-based learning compared to conventional learning.

Keywords: *industrial product-based learning, experiences learning, mechanical engineering skills*

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INTRODUCTION

Revitalization of vocational education learning should be built and develop in coherent with the competencies needed by the industry, so that appropriate learning innovations are obtained. The revitalization of learning must be able to improve the quality of measured, systematic and sustainable inputs, processes and outcomes. Vocational education revitalization policies instruct a need for learning innovation through synchronizing curriculum with industry and other partners, as well as strengthening the experience and competence of teachers. The curriculum and implementation of learning process must be appropiate to industry needs and the involvement of other stakeholders (Finch & Crunkilton, 1979). The basic principle of curriculum alignment constructively must consider the steps of learning to gain learning experiences in order to achieve the learning objectives (Kuhn & Rundle-Thiele, 2009).

The problems in vocational education learning innovations include: development of a lot of cooperation at the level of student internships with the industry, the lack of teachers, the results of curriculum alignment with industry have a little impact on learning innovation, vocational training has not been maximally carried out, curriculum alignment has not been implemented in learning, the resource sharing is not maximal. The principles in implementing vocational education is: (1) vocational education will be effective if teacher has had successful experience in applying skills and knowledge in the operations and work processes that will be carried out; (2) vocational education will be efficient if the teaching methods and personal relationships appropriate with student's characteristic; and (3) vocational education will only be effective where training tasks are carried out in the same manner, tools and machinery as determined at the workplace (Prosser & Quigley, 1959).

These conditions indicate that the lack of innovative learning models carried out as a follow-up to the development of aligning competencies with industry. Learning model innovations must continue to be done by following the development of competencies that occur in the industry. Learning model innovations are needed to improve learning experiences and student performance. Novel and more innovative learning strategies must be introduced and implemented in teaching and learning activities in order to facilitate the student's personal development (Leung & McGrath, 2010). These problems have impact on learning experience and student performance. The success on revitalization of vocational education learning is determined of the right learning model by the selection process that appropiate with industry needs, as well as the experience and performance that need by students. Thus, teachers must be able to create interesting learning experiences. Learning experiences are more interesting when refer to project that relevant to the industry (Hadgraft, 2017). Factory based learning has proven to be effective in developing theoretical and practical knowledge in real production environments. Factory based learning for production must be based on didactic, integrative and technical (Baena et al., 2017).

The concept of industrial products-based learning is a new paradigm of vocational learning, where the learning process integrates academic activities with industrial activities. This learning objective is to improve the student's learning experiences in schools and practice skills in industry (Rentzos et al., 2014). The industry needs for engineering graduates are developing, so we need new approach in education system (Uziak, 2016). The implementation of products-based learning must involve and work closely with the business and industry world, while vocational education provides sufficient skills and knowledge for the labor market and also provides sustainable education (Martinez Jr., 2007). The learning process in products-based learning can be designed with a focus on relevant competencies by expanding the adequacy in competency (Müller-Frommeyer et al., 2017). The benefits of collaborative project learning force students to work together for solving complex technological problems and developments, as well as encourage students to think critically (Mitchell et al., 2017). Products-based learning has proven to be an important tool to educate students and professionals about the practice application on the principles of production management (Erol et al., 2016).

The implementation of industrial products-based learning use the ACDIE stage (Alignment, Conceive, Design, Implement, Evaluation). Alignment stage is the most important stage in synchronize the needs with industry. This stage determines the types of products that will make by stu-

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dent and consider the competencies that will achieve, the equipment used, implementation of learning, and strengthening of work culture. The Conceive stage is a series of industrial products-based learning implementation processes, where students with the instruction from teachers discuss to determine what products will be produced. Teachers guide to choose the best from alternatives product that suggested by each group. Design stage make the detail of design based on the product that choosen from the alternative product. Each group divides the work, therefore, each member is responsible for the assigned work. Teachers ensure that the design is appropiate with the plan. Assistance and supervision from teachers is needed so that the implementation is appropiate with the design and the specified time.

The implementation stage is the product manufacturing stage. This stage determines students whether the product is successfully made and functions according to the design. Students need a lot of time to solve problems if the product is not functioning properly. Teachers need to provide motivation and direction so that students do not give up quickly. Evaluation stage is the stage of evaluating the process and the final product. Students communicate their performance and products in front of groups of other students, teachers, external reviewers or stakeholders if possible. The study was conducted to analyze the implementation of industrial product-based learning on machining industry in mechanical practices. This study was conducted also to analyze implementation of Mechanical Practices learning activities in industrial products-based learning. The learning process is a teaching and learning activity which consists of: giving perception and motivation, mastering learning materials, learning strategies implementing, implementing learning resources or learning media, involving students in learning, and closing the learning process.

RESEARCH METHOD

The research method used in this study is experimental method with static group comparison design. The design used two groups, namely the experimental and control group. The experimental group is the group of respondents treated with industrial products-based learning, while the control group is a group of respondents treated with conventional learning models (job sheet-based). The sampling technique used in this study is simple random sampling. There were 20 respondents in each group. The research respondents involved were students of Mechanical Engineering Department Universitas Negeri Semarang who joined Mechanical Practice 2 course. The respondents were already pass the Mechanical Process 1 course. The validity in this experimental research design used: (1) historical; (2) maturation; (3) statistical regression; (4) selection; and (5) mortality. Historical treatment control through group selection randomization and group members was plotted randomly. The maturation validity of the control treatment was randomized, while the validity of the selection was through the control group. Statistical regression validity control treatment used randomization and eliminated the extreme scores that appeared, while the mortality validity used subject acquisition

Research data collection used a learning activity questionnaire. The observed learning activities were related to the apperception and motivation provision, mastery of learning material, learning strategies application, learning resources or learning media application, students involvement in learning process, and closing the learning process. Data analysis techniques used the descriptive statistics and Mann Whitney *U* Test with data analysis application. The Mann Whitney *U* Test was used to analyze the differences between the two study groups. Descriptive statistics are used to analyze research variables based on the criteria that used. Interpretation of descriptive analysis can be shown in Table 1.

Table 1. Data Interpretation

Interpretation	Percentage (%)
Very good	76-100
Good	51-75
Less good	26-50
Bad	0-25

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RESULTS AND DISCUSSION

The results reveal a difference in the implementation of the industrial product-based learning with conventional learning in Mechanical Practices. The difference between industrial product-based learning and conventional learning is in the provision of apperceptions and motivation, mastering learning materials, implementing learning strategies, implementing learning resources or learning media, involving students in learning, as well as closing the learning process. Industrial product-based learning has an impact on improving the teaching and learning process of Mechanical Practices, the teaching and learning process in relation to the provision of perceptions and motivation, mastery of learning materials, implementing learning strategies, implementing learning resources or learning media, involving students in learning, and closing the learning process. The alignment stage becomes a decisive stage so that the implementation of industry-based learning is different. This stage aligns industry needs with academic activities in relation to the types of products that students will make, the level of competency achieved, equipment needed, learning process, and the strengthening of work culture. The process of aligning curriculum with industry must be designed and also developed appropriately so that programs can be implemented in the learning (Yudiono, 2017). Differences in the implementation of learning in relation to providing apperception and student motivation, mastering of learning materials, implementation of learning strategies, the use of media or learning resources, growing students' active participation, and also closing the teaching and learning activities. Learning process analysis result include giving perception and motivation, mastering the learning materials, implementing learning strategies, implementing learning resources or leaning media, involving students in learning, as well as closing the teaching-learning process.

Apperception and Motivation

Giving apperception and motivation when starting learning activities was done using several criteria, including preparing class activities and learning tools, informing the learning objectives, and motivating the students. Figure 1 shows that the use of industrial products-based learning for preparing class activities and learning tools increased by 53.85%, compared to conventional learning. Conveying learning objectives using the industrial products-based learning has increased by 30.16% compared to conventional learning. Motivating students to focus on learning using the industrial products-based learning increased by 79.17%, compared to the conventional learning. Giving apperception and motivation for the industrial products-based learning has very good qualifications.

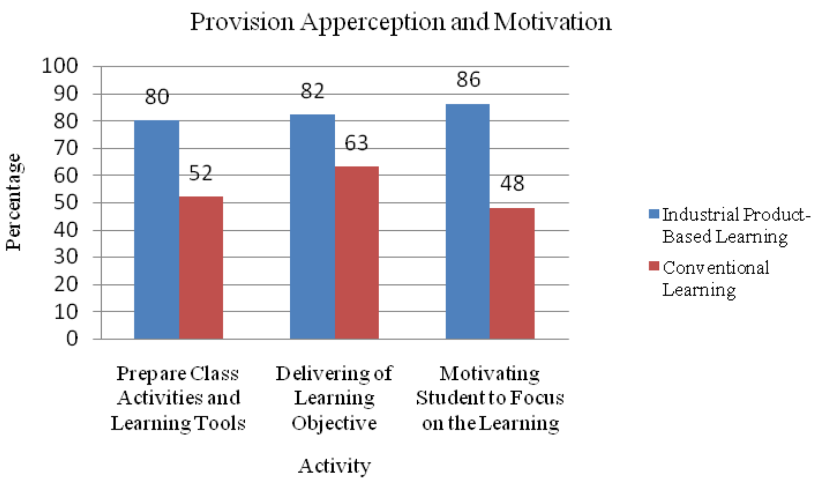

Figure 1. Provision Apperception and Motivation

Based on Table 2, it is shown that a *U* value is 8.000 and wilcoxon value is 218.000, if the value is converted to *Z* value the results is -5.244, Sig or *P* Value of .000 ($p < .05$). If the p value < .05, there is a significant difference between the industrial products-based learning and convention-

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al learning group in giving apperception and motivation to students. The differences in giving apperception and motivation activity in both learning models are in the preparing class and learning tools activities, delivering goals, and motivating students to focus on learning.

Table 2. The Result of Data Analysis in Difference of Provision Apperception and Motivation

	Apperception and Motivation
Mann-Whitney *U*	8.000
Wilcoxon *W*	218.000
Z	-5.244
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

Learning differences occur in the provision of apperception and motivation in preparing class activities and learning tools, delivering learning objective, and motivating students to focus on learning. Industrial products-based learning with the ACDIE stage is more concrete so that it can stimulate students' mind, feelings, concerns, and skills so can encourage the learning process. Industrial product-based learning with ACDIE stage is appropriate with the students' characteristics and motivates students to focus on learning because it is holistic, interactive, scientific, contextual, effective, collaborative, student centered and competency oriented. Motivation is an important factor on academic performance, high student motivation impacts in the improvement of better academic performance. Educators must be able to identify learning models that can increase student motivation (Daniel et al., 2019). Industrial projects increase student motivation. Work is directed at the application of developed knowledge and technology, involving many scientific disciplines, and stronger self direction (Mills, 2003). Learning design with approach in the industry contains curriculum structure, learning materials, achievement of competencies, competency evaluation so it can produce learning experiences and learning outcomes that expected (Febriana, 2017).

Mastery of Learning Materials

The ability to deliver material in industrial product-based learning increased by 20.29% compared to using conventional learning. The ability to link science and technology, relevant knowledge, and real life in industrial product-based learning increased 34.85% compared to conventional learning. The ability to answer questions on industrial product-based learning increased 56.37% compared to conventional learning. Overall, mastering the material in teaching and learning activities with industrial products-based learning has very good qualifications, as shown in Figure 2.

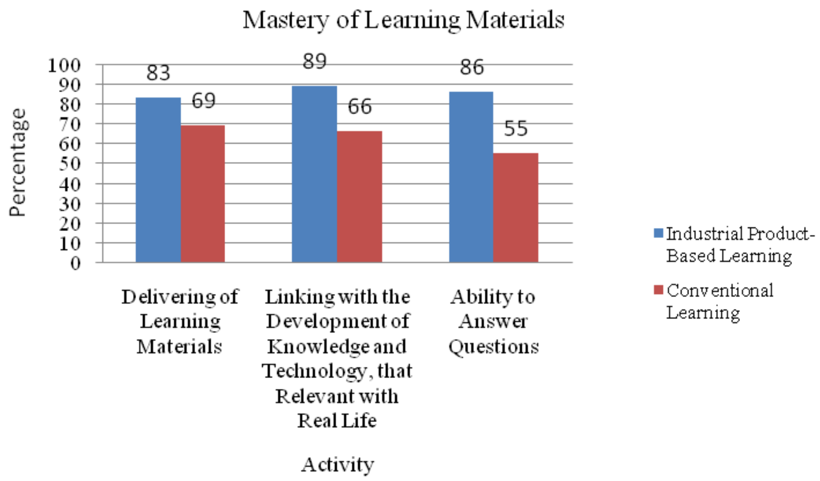

Figure 2. Mastery of Learning Materials

Table 3 shows that U value is 33.500 and wilcoxon value is 243.500, if that value converted to Z value then the result is -4.553. If the p value < .05, there is a significant difference between the industrial products-based learning and conventional learning group in mastering material. In mas-

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tering learning materials, there are differences in industrial products-based learning models and conventional learning. The differences can be seen in the ability to convey learning material, related to science and technology, knowledge that is relevant to real life, and answering questions.

Table 3. The Result of Data Analysis in Mastery of Learning Materials

	Mastery of Learning Materials
Mann-Whitney *U*	33.500
Wilcoxon *W*	243.500
Z	-4.553
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

Mastery of industrial products-based learning materials is better with the use of the ACDIE stage in delivering of learning materials, linking with the development of knowledge and technology that relevant with real life, and the ability to answer questions. Industrial product-based learning increases the student's ability to elaborate with work in the appropriate stages. Industrial products-based learning contributes to students' self development in competency that has been widely accepted (Lasauskiene & Rauduvaite, 2015). Learning models have good potency to increase student's interest and involvement in mastering learning material, encourage and empower learners to increase their responsibilities in learning, and enable students to actively ask questions and provide feedback to teachers (Park, 2003). This learning also provides motivation and real world assignments for students according to the demands of the job (Balve & Albert, 2015). Mechanical education must focus on develop student's creative thinking and ability to solve mechanical problems by design a creative learning that make creativity, critical thinking, and transfer of student mechanical skills (Wu & Wu, 2020). The involvement of teachers in designing and organizing teaching and learning activities is very necessary to keep students motivated and participate in every activity. Teacher involvement is a challenging task to improve learning performance and achievement. The student's learning achievement is always directly proportional to the involvement of teachers in designing, organizing, and evaluating learning (Joshi et al., 2019).

Implementing Learning Strategies

Figure 3 shows the accuracy of implementing industrial products-based learning strategies has increased by 71.43% compared to conventional learning. Fostering positive activities in industrial product-based learning has increased by 70.21% compared to using conventional learning. Soft skills in learning activities have increased by 63.46% compared to conventional learning activities. Based on these criteria, the application of industrial product-based learning strategies is very well qualified compared to conventional learning.

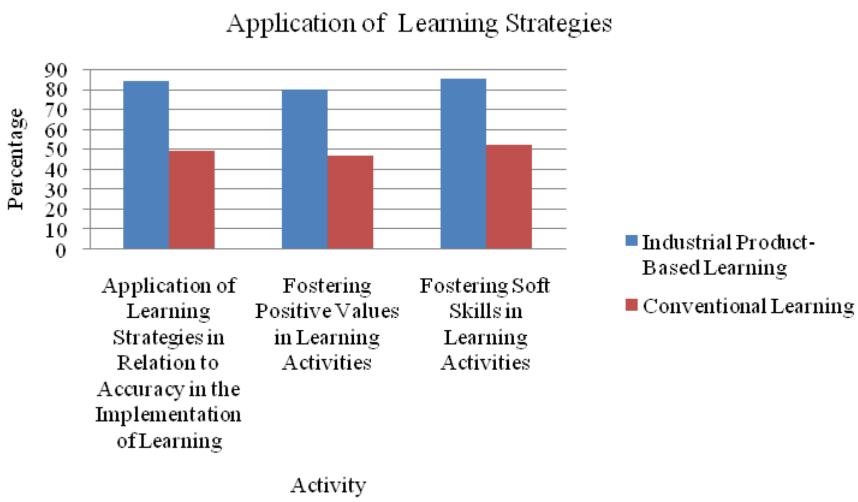

Figure 3. Application of Learning Strategies

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From Table 4, U value is 8.000 and wilcoxon value is 218.000. This value is converted to Z value and the result is -5.244. If the p value < .05, there is a significant difference between the two groups in implementing industrial product-based learning strategies. The differences in applying learning strategies in both models are in implementing learning strategies appropriately, fostering positive activities in teaching and learning process, and cultivating soft skills in learning activities. The difference is very clear in the ability to foster positive and soft skills in teaching and learning activities.

Table 4. The Result of Data Analysis in Application of Learning Strategies

	Application of Learning Strategies
Mann-Whitney *U*	8.000
Wilcoxon *W*	218.000
Z	-5.244
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

The industrial product-based learning implementation is better in applicating learning strategies. Learning strategies application is related to accuracy in the implementation of learning, fostering positive values in learning activities, and also fostering soft skills in learning activities. Industrial product-based learning use is a constant strategy to foster positive value in learning activities. This learning model can cultivate soft skills that are needed for vocational education graduates' competencies. Student competencies that must be mastered in the 21st century are critical thinking and problem solving, collaboration across networks and leading by influence, agility and adaptability, initiative and entrepreneurialism, effective oral and written, accessing and analyzing information, and also curiosity and imagination (Wagner, 2008). The right learning model selection helps improve learning experiences and student competencies after completing learning. Educational success is determined in choosing and applying the right learning model (Asfani et al., 2016). The effective and efficient learning strategies improve student's learning experience. The ineffective and inefficient learning strategies used by teachers impact the teaching and learning activities (Biwer et al., 2020). Student's learning experience increase their involvement in learning (Bizimana et al., 2020).

Implementing Learning Resources or Leaning Media

Figure 4 shows the selection and skills in using sources or media in product-based learning increased by 88.37% compared to using conventional learning. These results show the use of learning resources or media in teaching and learning activities using industrial product-based learning meets very good qualifications.

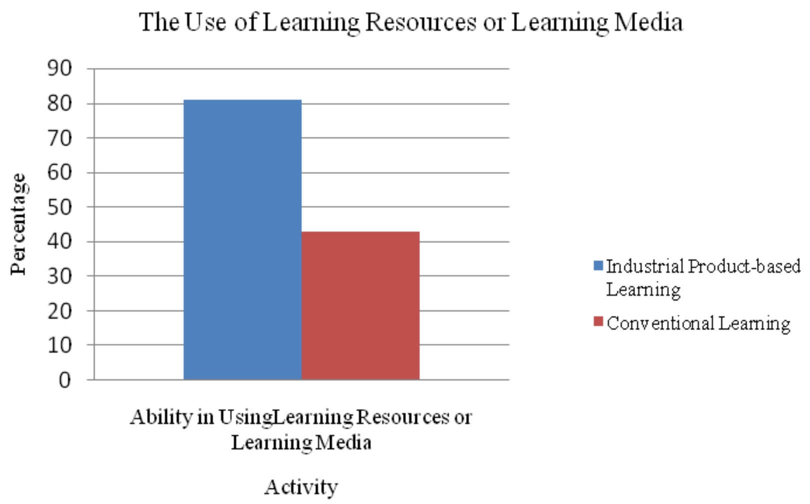

Figure 4. The Use of Learning Resources or Learning Media

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Table 5 shows that *U* value is 6.000 and wilcoxon value is 216.000. If converted to *Z* value, the result is -5.510. If the p value is < of .05, there is a significant difference between groups using industrial product-based learning with conventional learning in utilizing learning resources and media. The difference is seen in utilizing learning resources or media in both models, such as selecting sources or media, and skills in using resources and media in implementing learning. The use of learning resources or media with the industrial product-based learning is more effective and efficient in achieving learning objectives, so the teaching and learning process is easier, more concrete, and relevant to the learning objectives, and increases student motivation. Learning sources or media are important elements in teaching and learning activities to make it easier for students to improve understanding and learning outcomes, and to obtain maximum and understandable learning outcomes. The use of learning media or resources in industrial product-based learning can stimulate learning motivation to enhance the experience and understanding of learning innovations. The right approach and method in learning can increase motivation and value of education (Gregoriou, 2019).

Table 5. The Result of Data Analysis in the Use of Learning Resources or Learning Media

	The Use of Learning Resources or Learning Media
Mann-Whitney *U*	6.000
Wilcoxon *W*	216.000
Z	-5.510
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

Student Involvement in Learning

Activities to foster active participation through interactions using industrial product-based learning increased by 38.98% compare to conventional learning. The openness in responding students in product-based learning increased by 26.56% compared to using conventional learning. Activities to foster critical thinking, cooperation, creative and communication attitudes have increased by 38.00% compared to using conventional learning. The involvement of students in product-based learning has very good qualifications, these results are as shown in Figure 5.

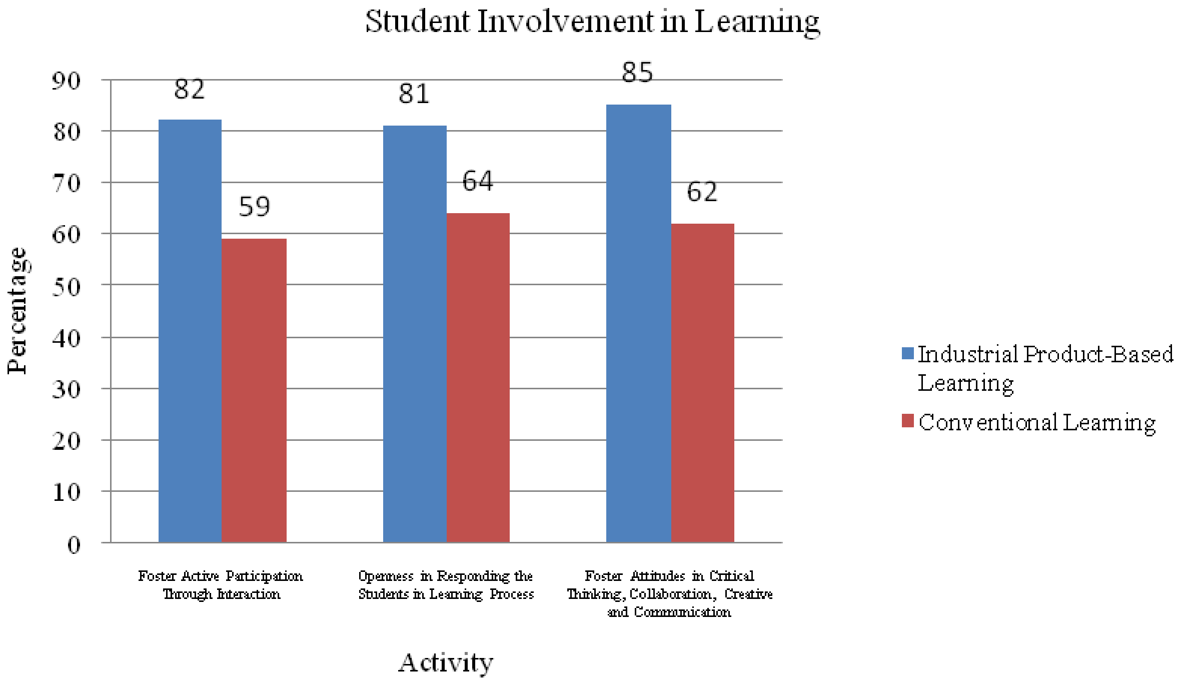

Figure 5. Student Involvement in Learning

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Table 6 shows *U* value is 26.000 and wilcoxon value is 236.000. The result of the conversion of that value to the *Z* value is -4.857. If the p value < .05, there is a significant difference between the group using industrial products-based learning and conventional learning in involving students in implementation of learning. The difference in the involvement of students in teaching and learning activities from the two learning models is in the ability to foster active participation through interaction, openness of teachers in responding to activities, and fostering critical thinking, collaboration, creative and communication attitudes of students.

Table 6. The Result of Data Analysis in the Student Involvement in Learning

	Student Involvement in Learning
Mann-Whitney *U*	26.000
Wilcoxon *W*	236.000
Z	-4.857
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

The use of this model is able to foster active participation through interaction, increase openness in responding the students in learning process, and foster attitudes in critical thinking, collaboration, creative and communication. Industrial products-based learning is able to increase student learning participation by promoting active learning. The model can also improve student communication and collaboration skills (Suswanto et al., 2017). Industrial product-based learning allows students to work together to solve real problems or challenges. Project diversity requires a lot of competencies from a variety of scientific disciplines, so students can increase their knowledge and development of complex technology, solve problems and think critically, and collaborate with teams for many types of work.

Closing Learning

The involvement of students in conducting final reflection increased by 26.98% compare to using conventional learning. Closing learning through written or oral evaluation has increased 23.08% compare to conventional learning in closing learning process. Follow-up learning increases 69.39% when compare to using conventional learning. The closing activity for industrial products-based learning has very good qualifications, these results are as shown in Figure 6.

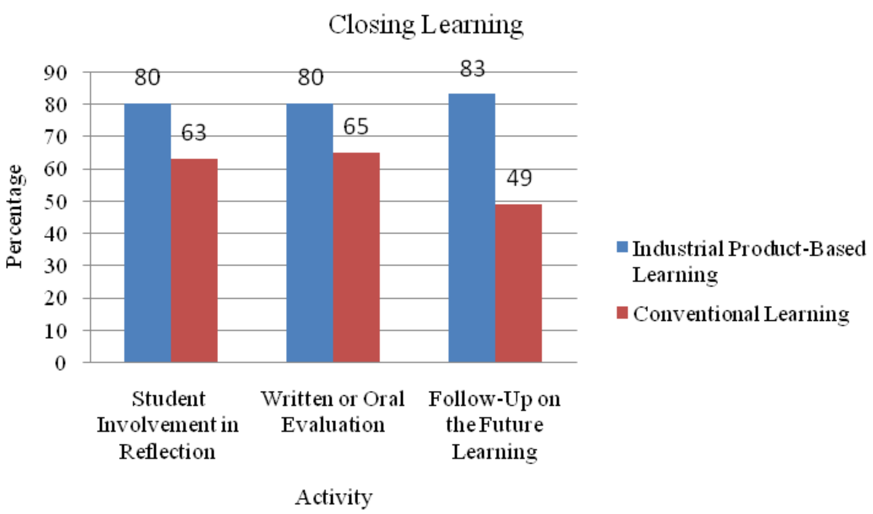

Figure 6. Closing Learning

U value is 17.000 and *W* value is 227.000. This value when converted to a *Z* value is -5.020, Sig or *P* Value of 0.000 (p < .05). Because the p value < .05, there is a significant difference between the two groups in closing learning activities as shown in Table 7. The difference in closing

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learning activities between industrial products-based learning and conventional learning model is in doing reflection involving students, conducting written or oral evaluations, as well as follow-up on future learning activities.

Table 7. The Result of Data Analysis in Closing Learning

	Closing Learning
Mann-Whitney *U*	17.000
Wilcoxon *W*	227.000
Z	-5.020
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

The implementation of closing learning in industrial products-based learning can increase student involvement in reflection, written or oral evaluation, and also follow upon future learning. These results show that closing learning activities can measure the level of student's and teacher's success in the implementation of learning especially in follow up on future learning. Measurement of success in industrial products-based learning is part of evaluation step. The success of the learning process is determined from the process and the suitability of the products. The success of the learning process measure by presenting the manufacture of industrial products from planning to producing of expected products. Each group presents the process of making products that appropriate with the objectives and application of the learning model accompanied by the teacher. Intergroup discussions allow students to improve self-reasoning, communication skill, practicing to work together. The results of the discussion as part of the evaluation will be use to improve the next performance. Evaluation of machining industry products is done by the teacher after presenting an evaluation of the implementation of learning process. Product evaluations use industry standard references. Instrument of product evaluation is in the form of dimensional accuracy, level of surface flatness, profile accuracy, timeliness of workmanship, and work safety. Limitations in the implementation of industrial products-based learning through the alignment of competencies such as the involvement of the industry in the implementation of learning, the involvement of process and product evaluations, exchange of resources, time synchronization of learning activities, and business planning assistance after the product is finished. The limitations need to be developed for the future implementation.

CONCLUSION

Based on the research findings, some conlusions are drawn, elaborated as follows. (1) Giving apperception and motivation process in implementing industrial product-based learning is better compared to conventional learning in Machining Practices. (2) Mastering the material process in implementing industrial product-based learning is better compared to conventional learning in Machining Practices. (3) Implementing strategies process in implementing industrial product-based learning is better than conventional learning in Machining Practices. (4) Applying learning resources or using media process in implementing industrial product-based learning is better than conventional learning in Machining Practices. (5) Involving students process in implementing industrial product-based learning is better than conventional learning in Machining Practices. (6) Closing process in implementing industrial product-based learning is more meaningful than conventional learning in Machining Practices. (7) There is a significant difference in giving apperception and motivation in the implementation of industrial product-based learning compared to conventional learning in Mechanical Practices. (8) There are significant differences in mastering material in the implementation of industrial product-based learning compared to conventional learning in Mechanical Practices. (9) There are significant differences in the application of strategies in the implementation of industrial product-based learning compared to conventional learning in Mechanical Practices. (10) There are significant differences in the application of learning resources or media in the implementation of industrial product-based learning compared to conventional learning in Mechanical Practices. (11) There is a significant difference in student involvement in the imple-

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mentation of industrial product-based learning compared to conventional learning in Mechanical Practices. (12) There is a significant difference in closing the learning process when implementing industrial product-based learning compared to conventional learning in Mechanical Practices.

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