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Development of Product Based Learning-Teaching Factory in the Disruption Era

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Abstract:
Based on preliminary studies and needs analysis conducted on learning web programming and mobile devices, it was found that the learning problem was not optimal. This study aims to develop a product-based learning model and teaching factory in Vocational Education that is valid, effective and practical. This research is a Research and Development, referring to the ADDIE model. The analysis technique uses Aiken'V test, and validity uses expert testing and Focus Group Discussion Practical tests are carried out on the application of products to students in the form of a product practicality questionnaire and to test product effectiveness with Two-Group Pretest and Postest Design experiments. The results of effectiveness tests for classes and limited classes are considered effective. Product-Based Learning Factory Learning Model uses 6 steps; need product analysis, design, product manufacture, product testing, product evaluation, and business plan making. This is evidenced by the competence of students between the control class and the experimental class, before being treated can be said to be almost the same, there is no significant difference. Improved learning outcomes that have been generated in the cognitive aspects are 20.70%, psychomotor aspects 18.32.68%, and affective aspects are 20.11%. From the three aspects of competence, it has a better impact on the application of practical material learning techniques. by adopting a model of Product-Based Learning Factory Learning that is feasible to apply.
Keywords: *Product Based Learning, Teaching Factory. R and D, Disruption Era, Vocational Education*

I. INTRODUCTION

The education paradigm in the learning process in technology and vocational education institutions, hereinafter in the XXI century is how to carry out the transformation of long life learning, education for all, life-based learning, and work place learning through various work experiences [1]. Vocational Education learning acquires adequate life skills career skills [2]. Technology and vocational education in the perspective of vocational education reconstruction, seeks to bring the working world environment into the organization of learning environments or formal educational institutions starting from the lowest level, middle level, and higher education level [3].

21st Century skills have become a fairly lively topic to be discussed lately. Educational institutions are challenged to find ways in order to enable students to succeed in work and life through mastering critical thinking skills, creative, flexible problem solving, collaborating and innovating [4]. The gap in achievement of the competencies of graduates of educational institutions, especially vocational and real needs in the world of work is still very far from the desires of the labor market. This can be measured by the low absorption capacity of the world of work towards graduates of educational institutions especially vocational education.

The high graduates of vocational education institutions that are not absorbed by the world of work have resulted in the existence of a productive level of job seekers whose absorption in the world of work has not shown encouraging results. It can be concluded that the quality of education is still low, especially vocational education, and so are other educational institutions [5].To address the above, educational institutions should be able to improve by making efforts in answering the problems mentioned above. One way is to develop a learning model that is relevant and suitable to the needs of the industry so that the realization of the learning process that is in harmony with the industrial environment, so that the graduates produced are relevant to the needs of the industry. Together the quality of graduates of educational institutions will improve

Something that shifts technology and can shake up existing industries or products and give birth to new industries is called technological disruption.[6] The business and industry climate is moving fast and increasingly competitive, as is the development of industry in Batam City and the development of information technology globally so that it greatly influences the world of work and the expertise needed. The challenge of vocational education graduates today is how to prepare graduates to face this industrial revolution. This new industrial pattern had the effect of creating new positions and job skills and losing several positions. skills and competencies must always be developed and improved according to the needs of the world of work and industry, and must be an important factor in facing and winning competition in the 21st century.

Changes that occur are very radical through the challenges and obstacles that overturn existing systems and challenges that are considered to have been replaced by new systems. The use of digital technology to create innovation characterizes the implementation of the industrial revolution 4.0. For example, manufacturing companies, device suppliers and customers will be connected to the internet of things (IoT) platforms, cloud computing, artificial intelligence, virtual reality and big data. Technology is not a barrier but a potential to increase productivity, even if there is still something left behind. Some sectors affected by disruption and must be able to adapt and follow the development of the model are manufacturing plants, banking, hotels, shops, and schools/ universities.

The outcome of the graduate majoring in Software Engineering on the subject of web programming and mobile devices is being able to analyze, design and create web-based software applications and mobile devices, gadgets or tablets as well as being able to make information products but the problems currently faced are products that are made only as a result of learning and have not been able to sell and entrepreneurial value to be used in the business world and industry. The learning process in web programming and mobile devices has not provided an opportunity for students to develop their potential and creativity. The learning process that can make it active and creative must be supported by sources and learning models that have work competence and are related to the business and industrial world, equipped with the ability to produce products, but the reality is not as expected so it is necessary to create a product-based learning model with an approach Factory teaching strategies are based on the era of technological disruption so they can be adapted to the needs of industry and business.

Vocational High Schools in Batam City, which are said to be Industrial Cities, have not implemented teaching factory teaching models and are very ironic, even though the users of Batam City Vocational High School graduates are industrial and business world, which are multinational companies from foreign countries. Many teachers also do not fully understand the teaching factory learning model and how an industry and the business world make the process of making products to be marketed and in demand. The current learning model is also felt to be less interesting, boring, does not make students more creative and more challenged to produce a product whose process resembles the process of making products in the industrial world, still much focuses on providing piecemeal skills, not all [7]. Almost all learning processes are carried out routinely, where students come, the teacher is present in front of the class, providing theoretical and instructional explanations to practice to create applications and then test applications or products that have been produced but the products produced have not been validated by the industry according to their needs .

For this reason, a learning model that can solve supply and demand driven problems is needed, a learning model that makes it more active, creative and productive and innovative that has an entrepreneurial and strategic spirit with an approach towards teaching factory that has the value of technological disruption [8]. For this reason, it is very urgent to bring education and business world closer together so that they can communicate and collaborate with each other, the education world can keep abreast of developments in the industrial world, namely the use of information technology-based products. A very important factor in the era of technological disruption and the industrial revolution 4.0 is the mastery of competent technology and human resources in order to produce a product with a teaching factory strategic approach that has economic, entrepreneurial and creative value because 56 percent of the Indonesian labor market is very vulnerable to changes caused by technological disruption.

Learning Model is one of the important and main components in supporting the learning process and the results of the learning process itself. To improve the results of the learning process it is necessary to improve the utilization and management of the learning process itself so that the expected goals can be achieved together. Learning model is a plan or a pattern that is used as a guide in planning learning in class.[9] According to Arend [10] also states "The term teaching model refers to a particular approach to instruction that includes its goals, syntax, environment, and management system". According to Joyce, Weil & Calhoun [11] the learning model is a conceptual framework that describes a systematic procedure in organizing learning experiences to achieve certain learning goals and has a function as a guide for learning designers and instructors in planning and implementing teaching and learning activities.

With the era of disruption, it must be able to create learning positions that are fun, stimulate creativity and a democratic atmosphere. The world of vocational education must improve in the face of the era of disruption. Teachers must be literate with technology, the class will be a study group gathered in groups of whatsapp, telegram, google classroom, edmodo and others as well as academies from vendors of large companies that are provided free of charge such as cisco academy, mikrotik academy, academy ec-council. The teacher can easily convey material and assignments through these media and can also teleconference with the technology so that distance and time are not obstacles. Teacher self-development in the era of disruption must always be updated and technology literate, not to stop. Teachers must be able to manage classes offline and online, be able to upload teaching materials to the online system and be able to answer each of their students' questions about novelty technology. And in my opinion the disruption for a teacher is the solution is self-development.

In this 21st century, education throughout the world is in the era of internet-based, knowledge-based information and communication technology with the term industrial revolution 4.0. It can be said that the industrial revolution 4.0 is a paradigm that occurs when the work environment in the business world and the industrial environment should be adopted into the world of education [12]. One of them is by developing a concept of a product-based learning model with the Teaching Factory approach in the hope that it can contribute to creating a better learning process effectively and efficiently, and can also be used as an example or role model for something that changes in educational institutions especially vocational education.

Expected contribution to the implementation of a product-based learning development model with a teaching factory approach is to be able to innovate in the implementation of learning in vocational education, namely by extracting the behavior of learners to be more independent in implementing learning so that it can change the state of the practice learning process from all components of the model that are that is required from the aspects of the learning approach, learning strategies, learning methods, and learning techniques [13]. By paying attention to the facts as explained above, the learning process especially in practical classes to be more comprehensive, it is necessary to develop a product-based learning model which in its implementation is supported by a set of module books containing potential SCL-based material to meet the demands of learning.

The product-based learning model in its implementation stage is a part of active learning, creative and able to provide opportunities for the development of the potential of every student [14]. Providing changes in work culture according to the industrial world environment and improving the quality of psychomotor skills in the learning process for practical classes. The learning model with the TEFA teaching approach can meet the demands of stakeholders, students will benefit from hands-on practical experience mentored by practitioners according to their fields of expertise, and team-based learning experiences involving students, lecturers, and industry participation enriching the educational process and providing benefits which are real for all parties.

The quality of vocations in Indonesia must still be improved and continue to be a concern and priority. Various challenges are still faced in the implementation of vocational education, especially in the era of disruption of the industrial revolution 4.0 [15]. Indonesia itself still faces the problem of a mismatch between the orientation of education and the needs of the business and industrial world. The high percentage of vocational education graduates who have not yet found work. A total of 131.06 million Indonesians are in the labor force, the number increased by 2.92 million people from August 2017. In line with that, the Labor Force Participation Rate also increased 0.59 percentage points. In the past year, unemployment decreased by 40 thousand people, while the Open Unemployment Rate (TPT) fell by 5.34 percent. Viewed from the level of education, the Open Unemployment Rate (TPT) for vocational education graduates still dominates among other education levels, which is 11.24 percent [16].

Ganefri [14] states, "the production-based learning model is defined as the procedure or step that needs to be performed by the educator to facilitate learning learn to active learn, participant and interact with a competency orientation to the procedure either product or service is required". Product-based learning model is a process of expertise or skill education that is designed and implemented based on real job procedures and standards to produce goods or services that meet business and industry standards and the community in accordance with their needs. And surely this product-based learning model fits and fits into the concept of vocational education.

In general, the development of a product-based learning model with a teaching factory approach aims to train students in achieving punctuality, the quality demanded by businesses and industries and entrepreneurship, preparing according to their competency expertise, instilling a mentality of creativity and productivity by directly producing products that can be used in the business and industrial world as well as entrepreneurship [17]. Noting these things, this study aims to identify the conditions of implementing the development of learning models for web programming subjects and mobile devices, viewed from the aspects of students, teachers, industry practitioners, teaching materials, instructional media, learning models, learning facilities and infrastructure as well as time spent needed. In addition, this study also aims to find alternative learning models that can improve student competencies in these productive subjects, especially in terms of finding a product-based learning model with a teaching factory approach that can develop vocational skills, rational thinking skills, social, practical, effectiveness, as well as finding learning models that can develop students' self-awareness and abilities that are high and ready to develop as industrial workers, the business world and entrepreneurship.

The teaching concept of teaching factory is actually a real learning concept that brings students closer to the business world and the industrial world and can produce graduates who are creative, innovative, competitive, independent-minded and ready for work and entrepreneurship and are able to compete in the global market [8]. For the implementation of the teaching factory learning process requires careful preparation because this study learns the process of production activities and also the application of industrial culture and will be successful if the process is carried out like industry and business world standards.

In addition to careful preparation of teaching factory learning success requires clear parameters that can be used as a measurement of learning success in vocational education, especially in the implementation of teaching factory learning. With the concept of teaching factory learning that students are truly faced with learning situations, the environment, the contents and assignments that are relevant, realistic, authentic and presents the natural complexity of the real world so as to be able to provide personal experience to student objects and information obtained by students.

II. RESEARCH METHOD

The research model used in this research is development research. Development research is a systematic study of the design, development and evaluation process of "interventions" (programs, learning strategies and their tools, products, and systems) aimed at increasing knowledge about the characteristics of "interventions" and the design process, and their development [18].

Seels & Richey [19] defines Research and development as a systematic assessment of the design, development and evaluation of programs, processes and learning products that must meet the criteria of validity, practicality and effectiveness. Research and development is used to develop products such as the development of learning materials, learning media, learning strategies, and learning management.

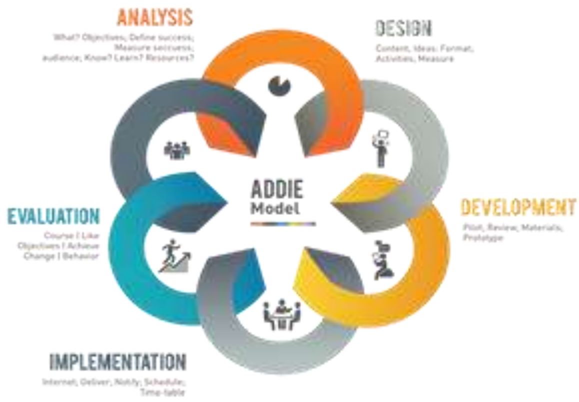

Fig. 1 ADDIE Model

Experimental trials were conducted using the Two-Group Pretest-Postest Design research design. Before the model treatment is given first pretest, this is done to compare the conditions before and after treatment [20]. The research design can be seen in the figure 2:

$$Q_1 \ . \ Q_2$$

$$Q_1 \times Q_2$$

Fig. 2 Research Design Development Model

Teaching factory-based Product Based Learning model development research uses ADDIE model learning design with several considerations, namely: ADDIE model has more systematic characteristics because it has five interrelated and sequential components. The ADDIE model is a guide for program designers, educators and instructional developers in creating learning programs that are effective, efficient, interesting and easy to understand. The ADDIE model is more general in nature so that it is more easily understood by the developers of learning and training programs, as well as lecturers, teachers, and training instructors as educators. According to Branch [21] the ADDIE instructional design model was developed in the 1990s by Reiser and Mollenda to design learning systems.

Data collection will be conducted from SMK AL Azhar Batam students in the Department of Software Engineering and teachers as well as the industrial world with instruments designed for that. To collect information from various sources, a questionnaire was used to collect data. Quantitative data are analyzed using descriptive statistics and inferential statistics. Inferential statistics use a different test with a t-test to see the difference between expectations and the conditions of achievement now. The results of the discussion and discussion will provide recommendations for learning models that can improve the competence of vocational education graduates.

III. RESULTS AND DISCUSSION

Data description of the results of the study revealed the procedures and results of the development that had been carried out based on the development steps used. The research and development procedures carried out in this study use the ADDIE design with Analysis, Design, Development, Implementation, and Evaluation description of the research results:

Preliminary Studies (Need Analysis)

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Preliminary Study (Need Analysis) Preliminary research results obtained some information that became the basic reference in the Development of Product Based Learning Model - Teaching Factory and the system or product support (support system) in the form of model books, teaching materials, teacher manuals and student manuals. Preliminary research results are obtained from direct observation, discussion, educators or teachers at the researchers' place conducted by researchers, education practitioners and policy makers (stakeholders) as well as literature studies on models and learning materials.

The conditions of the previous learning process activities, students are passive, inactive and not independent, depend on the teacher's explanation, students are still unable to make decisions and have not been able to fully solve the problem through projects that are made as practicum activities and as conditions for completing the educational programs undertaken. Therefore, the strategies implemented in the learning process are generally still dominated by the teacher (teacher center learning) [22]. The teacher is still the center of the learning process, student activities should be more than the teacher, students must be active and independent with student-centered learning patterns (student center).

Teaching Factory-based Product Based Learning Model is considered suitable to be applied in vocational education institutions, so that it is expected to improve the competence of students and graduates through learning patterns of Teaching Factory-based Product Learning in mobile programming in the Software Engineering major.

At this stage also an analysis of the characteristics of students in the form of a general ability of students about mastery of the material and the ability to solve problems so that the level of difficulty of the test, the form of the test, and writing are attention and easy to understand. Through the analysis of student characteristics, it is obtained that most of the students are still not accustomed to describing, identifying and solving problems independently, interaction does not appear among each other, activities are still low and do not have the ability to make decisions about something that will be made.

Such conditions and a description of the data obtained, it is needed an innovation in learning in vocational education institutions. The innovation is by developing a Teaching Factory-based Product Based Learning Model and its support system or products in the form of model books, teaching materials, teacher manuals and student manuals. The innovation made is to make changes with the aim of getting better things in education [23].

Phase of Product Development

Based on the results of preliminary research (analysis) that has been carried out, the Teaching Factory-based Product Learning Model is based on Teaching Factory and its support system (product system) in the form of model books, teaching materials, teacher manuals and student manuals. Furthermore, it is necessary to see the achievement of models and products developed through testing the validity, practicality and effectiveness of the model.

The concept of the learning model Joyce et al. and Arends broader than the concept of strategy and learning methods. Thus, using the learning model offered by Joyce et al. and Arends [11] means that they have used methods and learning strategies that are arranged systematically and has been tested extensively through research to achieve the expected competence through the developed model. Sintaxs of Product Based Learning -Teaching Factory as shown on figure 3.

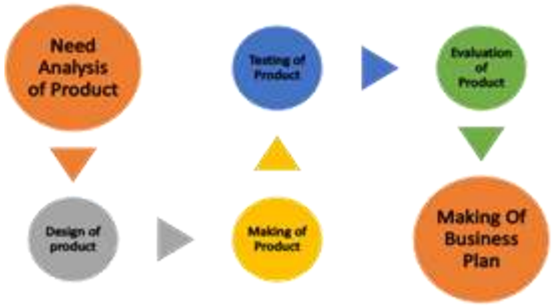

Fig. 3. Syntax of Product Based Learning -Teaching Factory

The syntax or sequence of product-based learning model activities for web programming and mobile devices is developed using the syntax of six steps as shown in the table 1:

Table 1 Description of Activities Model

Syntax	Students Activity
Syntax 1 : need analysis of Product	Students do an analysis of the needs of the product to be made
Syntax 2 : Product design	Students design products that will be made according to the analysis that has been done
Syntax 3: Making of product	Students make products skillfully based on material that has been taught can be a product that is web-based or a mobile device
Syntax 4 : Product testing	Students test the products that have been made skillfully based on the material that has been taught
Syntax 5 : Product Evaluation	Students evaluate the products that have been produced skillfully based on the material that has been taught and compare products that have been designed from scratch
Syntax 6 : Making of a business plan	Students can make business plans and sell products they have made

a. Validation of Sintax Model

Based on the results of statistical data processing using the CFA concept with LISREL software version 8.80, declared valid or fit (goodness-of-fit models) developed showed that the syntax construct of Teaching Factory-based Product Based Learning models, validated by 5 validators, to meet the criteria goodness-of-fit models.

Figure 4 is the result of CPA syntax 6 to 8 Chi-Square value = 67.40 with a P-Value = 0.94101, while the RSMEA value = 0.000. Based on the analysis of the data above shows that the validation construct of Product Based Learning-Teaching Factory syntax consisting of 5 validator elements meets the criteria for goodness-of-fit models, so that the value of the syntactic construct validity can be grouped or classified as valid or fit.

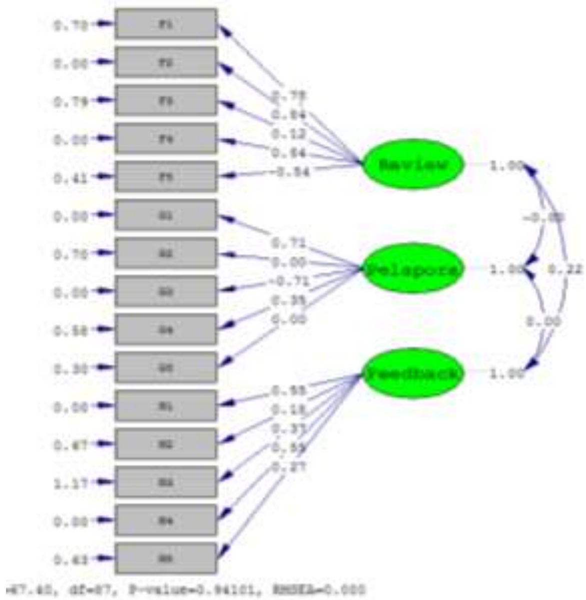

Fig 4. Result of Analysis Model Synthesis

b. Model Product Content Validation.

For Product Based Learning - Teaching Factory model product content, validated by 5 validators, meet the Aikens Value requirements, (≥0.066≤1.00), so that the model product book content validity is classified or classified as valid.

c. Test the practicality and effectiveness

Practicality Tests for the average teacher and student decision state "very practical" as well as for the effectiveness test of the control class with the experimental class with the average difference in pre-test scores with the post-test seen a linear increase, as well as effectiveness tests, such as figure 5 :

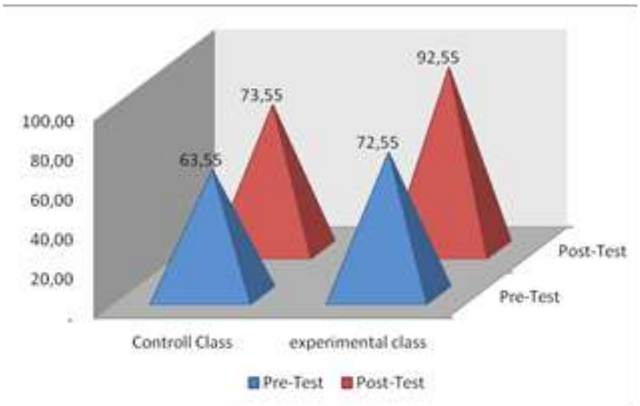

Fig 5. Differences in the values of the Control and Experiment classes.

d. Normalitas Test

Using the Shapiro Wilk statistical approach, when using a test sample or respondent ≤ 50, with a significant level (Sig => 0.05). The analysis showed that for the control class Sig = 0.243, and the experimental class Sig = 0.36, the pre-test value. As for the post-test value from the SPSS analysis version 22 when using a test sample or respondent ≤ 50, with a significant level (Sig => 0.05).

Table 2 The Result of Normality Test

One-Sample Kolmogorov-Smirnov Test

		Kelas Eksperimen	Kelas Kontrol
N		20	20
Normal Parameters[a,b]	Mean	68,7000	80,1800
	Std. Deviation	2,54889	1,14873
Most Extreme Differences	Absolute	,206	,230
	Positive	,195	,230
	Negative	-,206	-,148
Kolmogorov-Smirnov Z		,921	1,027
Asymp. Sig. (2-tailed)		,364	,242

a. Test distribution is Normal.

b. Calculated from data.

The normality test results of the proposal evaluation in table 2 shows the Asymp value. sig. (2-tailed), for the experimental class of 0.364 and the control class of 0.242 which means> from 0.05 means that both proposal assessment data are normally distributed.

e. Homogenity Test

Homogeneity test is carried out on product valuation using Levene test with SPSS software with data criteria said to be homogeneous if the significance level is greater than 0.05. The test results can be seen in the table 3:

Table 3 The Result of Homogenity Test

Test of Homogeneity of Variances

Kelas Eksperimen

Levene Statistic	df1	df2	Sig.
1,806	4	15	,180

Test of Homogeneity of Variances

Kelas_Eksperimen

Levene Statistic	df1	df2	Sig.
,965	3	13	,439

It was explained that showed significant requirements (Sig => 0.05). The analysis showed: Sig = 0.180, df2 = 15, and df1 = 4, for the pre-test value. shows significant requirements (Sig => 0.05). The analysis shows: Sig = 0.65 df2 = 13, and df1 = 3, for the post-test

f. T-Test

The t test was carried out by the two independent test mean mean. T test was performed using SPSS software with a significant level α = 0.05. The test results can be seen in table 4.

Table 4 T Test Posttest Control and Experiment Class

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Nilai	Equal variances assumed	3.177	.081	2.836	50	.007	3.93696	1.38806	1.14897	6.72496
	Equal variances not assumed			2.868	47.882	.006	3.93696	1.37258	1.17703	6.69690

Based on the SPSS results presented in table 4, the equal variaces assumed (homogeneous sample) has a sig value of 0.007 <0.05 which means that there are significant differences in the learning outcomes of the control class and the experimental class. So it can be concluded that there are differences in learning outcomes between students who use the Product Based Learning-Teaching Factory model compared to students who do not use the Product Based Learning-Teaching Factory model in computer network courses.

Based on the data obtained from the analysis of existing data, under increasing student competence from all aspects of this study, it shows a comparison of cognitive values, psychomotor values, and affective values for the control class and the experimental class has increased, meaning there are differences from each - even though the class is not significant between using the Teaching Factory based Product Development Learning model and by not using the model. These three aspects of assessment are the main indicators measured in this study, so it can be concluded that the results of these three aspects justify that the model is feasible to use. Graphically it can be seen in Figure 6:

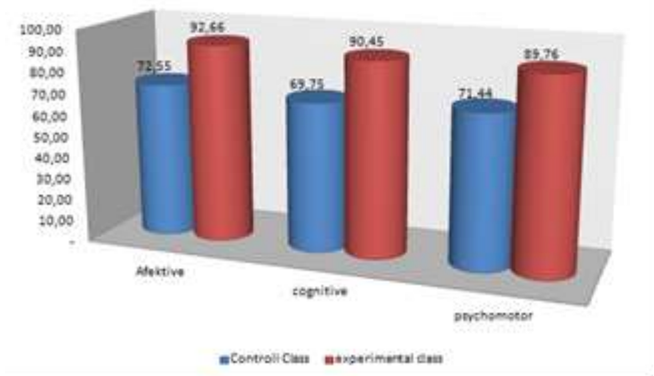

Fig 6. Comparison of Affective, Cognitive and Psychomotor Values, Between Experimental and Control Classes

Comparison of the average value of cognitive aspects of each control class with the experimental class of 22.1%, for psychomotor aspects increased by 27.6%, and affective aspects of 21.6%.

IV. CONCLUSION

Development research has resulted in a Product Based Learning-Teaching Factory model in the subjects of mobile programming in the Department of Software Engineering, based on the results of the validity test of the syntax constructs & content of the Product-Based Learning-Teaching Factor model, stated goodness-of-fit models and valid, so also with practicality and effectiveness. The validity test results of the product-based syntax & content of the Product Based Learning-Teaching Factory model, are stated to be goodness-of-fit models and valid, as well as the practicality and effectiveness, Normality Test, Homogeneity and T-Test, fulfilling the requirements. An increase in student ability between the control class and the experimental class is = 19, 71% with details of the cognitive aspects = 20,70%, psychomotor aspects = 20,11%, and affective aspects = 20,11. Product Based Learning Model -Teaching Factory has an impact on mobile programming learning, so the model is feasible to apply.

The Product Based Learning Model - Teaching Factory can be applied to other subjects with the same characteristics of the course, and this model provides a broad range of space in increasing competency from the aspect of knowledge (cognitive), aspects of skills (psychomotor), and aspects of behaviour / attitude (affective), so that this model can answer the problems that exist in the Disruption Era. This model is a new model in the implementation of practical learning, in the era of competition in the world of work, between countries in ASEAN today.

The Result of Product-Based Learning-Teaching Factory Development is the answer to the steps of revitalization of vocational education launched by the Ministry of Education and Culture in building educational institutions that are linked (link) with competencies developed by educational institutions that are in line with the competencies needed by the world of work (industry).

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