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A New Syntax of Teaching Factory IR 4.0 Model in Vocational Education

Surfa Yondri[a,b], Ganefri[b,1], Krismadinata[b,2], Nizwardi Jalinus[b,3], Sukardi[b,4]

[a]*Department of Electrical Engineering, Politeknik Negeri Padang, Limau Manis, Padang, Sumatera Barat, 25164, Indonesia*
E-mail: surfa_yondri@pnp.ac.id

[b]*Technical and Vocational Education, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar, Padang,25171, Indonesia*
E-mail: [1]ganefri1@gmail.com; [2]krisma@ft.unp.ac.id; [3]nizwardi@ft.unp.ac.id; [4]sukardiunp@gmail.com

***Abstract*— The competencies needed in the industrial revolution 4.0 (IR 4.0) era are critical thinking, creativity, communication, and collaboration. It is challenges and opportunities that exist in the period of IR 4.0 for vocational education. Therefore, it requires learning models that answer this. This study aimed to develop a new teaching factory model syntax that relevant to revolution industry 4.0. This study used mix qualitative and quantitative method. Syntax assessment was conducted through a focus group discussion attended by seven experts. Experts suggestions as qualitative data in this study and the qualitative method validated the experts' model through a questionnaire. Questionnaire data analysis used Aiken's V formula. A new syntax of the teaching factory model was developed based on three principals of the learning model, i.e., project-based learning, production-based learning, and teaching Factory. The implementation of the learning process was conducted by the hybrid system (face to face and online learning). Expert comments and suggestions are subject to fix and increase the completeness of a new syntax of teaching factory to be a learning model. Analysis results of expert validation showed that a new teaching factory model was valid and reliable to be applied in the learning process. Further study was needed to reveal the effect of new teaching factory syntax that is used in the learning process. Then, suggestions and revisions that might happen in further study.**

***Keywords*— teaching factory model IR 4.0; vocational education; learning management system.**

I. INTRODUCTION

Revolution Industry 4.0 is a paradigm shift that has the purpose of establishing network digitalization and virtualization in all industry fields [1], [2]. Therefore, vocational higher education has to produce a graduate who can compete in the revolution industry 4.0 era [3]. Business progress of the industry world is integrated into the labor produced by vocational higher education. The graduate of vocational higher education must have a competency needed by the revolution industry 4.0 era, namely technical skill, thinking skill, and generic skill [4], [5]. The learning process has an important role in developing these skills, so educators must prepare the right learning model to create an effective learning process. The right learning model was also chosen; it can produce the vocational higher education graduates with revolution industry 4.0 competency needs.

Teaching factory is a learning model that is reliable to produce the vocational higher education graduates with revolution industry 4.0 competency needs. The teaching factory was born from The University of Puerto Rico-Mayagüez and the University of Washington educators' though [6]. Educators' views of the vocational education environment also underlie teaching factory concepts to prepare them for work. The teaching factory provides knowledge and experience in processing, producing, and marketing [7]. The teaching factory model's learning concept has a relevant competency that students have to industry needs [8]. The teaching factory can increase students' competency, develop vocational skills, reasonable thinking skills, and social and personal skills. Also, prepare students to have competency relevant to industry needs [9], [10].

Revolution industry 4.0, which happens in the 21st century has changed the production process in industry and makes a change in the learning process conducted in vocational higher education. The rapid development of the internet makes the learning process undertaken by long-distance (not face to face). The learning process in vocational education cannot be conducted by long-distance using the internet thoroughly. Practice activities to train the hand skill, operate the machine, make a product, and maintenance must be conducted by face to face learning process. Therefore, it needed the right learning model to prepare the vocational higher education graduates with

revolution industry 4.0 competency needs. This article aims to describe a new teaching factory model that developed relevant to the revolution industry 4.0 needs today**.**

II. Material and Method

This study used mix qualitative and quantitative method. Syntax assessment, hierarchy, learning activities were developed by experts' suggestion, which was invited in the Focus Group Discussion (FGD). Experts who were invited as interviewees were seven experts with various educational backgrounds that relevant to model development. Experts invited data was shown in Table 1.

TABLE I
EXPERTS AS INTERVIEW DATA

Initials	Expertise
YA	Language
KR	Vocational Education of Information Technology
ID	Vocational Education of Electrical Engineering
Y	Information Technology
DI	Information Technology

The quantitative method used in this study was the validation of model. A new syntax Teaching Factory for 21st Learning Century was assessed by experts using a questionnaire. Four aspects were used to assess a New Syntax Teaching Factory Model are follow:

- The stages of the learning model can be applied.
- The stages on the learning model has a logic learning sequence.
- Syntax of the learning model describes the lecturer's roles in detail and clearly.
- Syntax of the learning model describes student's roles in detail and clearly.

Questionnaire analysis data used Aiken's V content validity formula that shown on the formula 1 [11]. Validation value of the assessment aspect is a sigma (Σ) from the number that given by evaluator (r) minus lower number of validity assessment (lo) divided total of evaluators and times higher number of validity assessment (s) minus 1. Aiken's V calculation between 0 and 1 and number of 0,6 can be interpreted with a high coefficient and can be avowed as a valid category.

$$V = \Sigma s/[n(c-1)] \quad (1)$$

III. Results and Discussion

A. Basic Concept of Development

Teaching Factory learning model that developed is combining of three models, namely project-based learning [12], [13], production-based learning [14] and Teaching Factory [15] and using networking learning system or known by the term Learning Management System LMS) (Figure 1). Learning principles of all three learning models and LMS were created to be a new learning model called by teaching factory model IR 4.0.

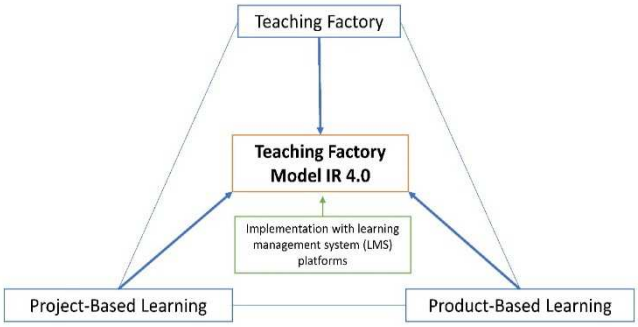

Fig. 1 Basic concept of a new teaching factory IR 4.0 model development

This model's development is an effort to answer the challenge and change that happen in the 21st century on vocational education today. Vocational education is not only prosecuted for producing students with professional skills, but vocational education can also have a product that can be sold in the market [16], [17]. Project-based learning model was based project identification of market need, writing proposal, and conducting project. Production-based learning modes were based on the product manufacturing process relevant to Standard Operational Procedure (SOP) and the Quality Control for a product. Teaching Factory model was based on learning process, which attends industry in the learning class. LMS was used as a learning complement with using networking learning system which characterizes of 21st century learning.

B. Validation

Expert assessment result on A New Syntax Teaching Factory Model and data analysis using Aiken's V formula was presented in Table 2. Experts' validation results are shown that the quality aspect of A New Syntax Teaching Factory Model was valid category. All four aspects fulfill the requirements as a learning syntax. So, it is reliable to be applied on the learning process in the higher vocational education.

TABLE II
VALIDATION ANALYSIS RESULT OF TEACHING FACTORY IR 4.0 MODEL

No.	Assessment Aspects	Validators' Assessment					∑ s	Aiken's V	Category
		V1	V2	V3	V4	V5			
1	The stages on the learning model can be applied.	4	4	4	5	5	17	0.85	Valid
2	The stages on the learning model has a logic learning sequence.	4	4	4	5	4	16	0.8	Valid
3	Syntax of learning model describes the lecturer's roles in detail and clearly,	4	4	4	4	5	16	0.8	Valid
4	Syntax of learning model describe student's roles in detail and clearly.	4	5	5	4	5	18	0.9	Valid

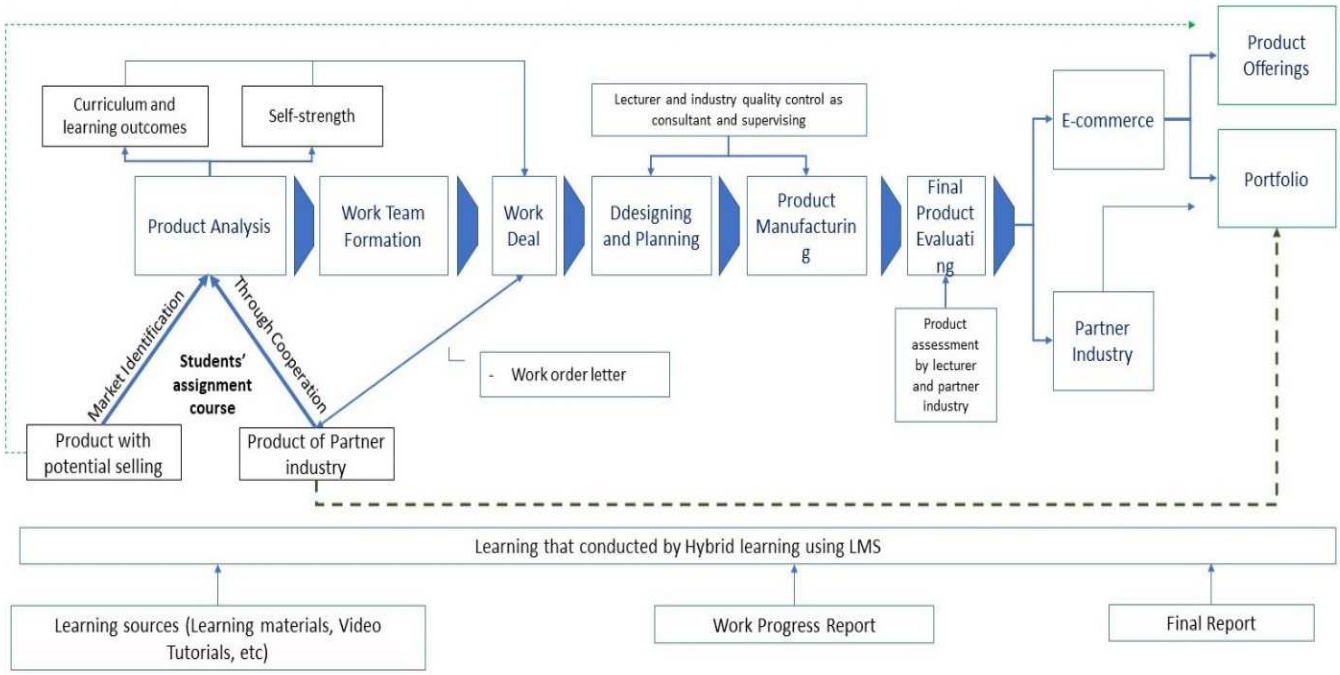

Fig. 2 A New syntax teaching factory model

C. A New Syntax of Teaching Factory IR 4.0 Model

A new syntax teaching Factory Model IR 4.0 that developed does not eliminate the existing teaching factory process. But process and activity can be conducted wherever and whenever by perfecting through entrepreneurship element of it. The project-based learning model principle conducted the identification process of market need. Product manufacturing process or services used production-based learning model principle. Learning system was conducted by using LMS which characterizes of 21st century learning. The syntax stages of the Teaching Factory IR 4.0 Model were shown on the Figure 2.

Syntax of Teaching Factory model consists of seven learning stages. Understanding of each syntax is described as follows:

1) Product Analysis: Product analysis or services is a core of practice learning and vocational education, and for project-based learning, production-based learning, and teaching factory model. Product or services is designed in the first learning position. Product or services on learning is sourced from consumer order and product which can be sold. Product or services has analyzed the suitability with curriculum and course learning outcomes. Lecturer and students analyze the product that will be designed or services conducted according to course competency. Then, that need to be analyzed is self-strength, it means that students competency skill to make product and existing the tool and machine to make the product. The self-strength analysis must be considered, it is related to the quality of the product produced. The products are not related to consumer demand specifications. It has negative image consequences for the campus. Analysis is needed to see according to students' initial skill and learning style related to the curriculum used [18].

2) Work Team Formation: In this stage, the work team (2-3 people) aims to agree on the good work organization, so the working result of goods or services production can run optimally. Work team formation is important because communication and collaboration can be applied well to the teaching factory process on the revolution industry 4.0 era [19]. Lecturer has role as a supervising and feedback provider to students in this work team formation process.

3) Work Deal: Work deal is related to administrative agreement and employment contract with consumer. This knowledge is very useful for students after graduate, if they build their own business. Document content and form of employment contract often do not as material in the vocational education learning. Through the implementation of this model, students will study how to write employment contract documents. Lecturer as facilitator to make work deal between work team (students) and consumer. Students conduct employment contract with consumer. Students will directly interact to consumer, so it expected that they be able to get direct experience how to contract agreement process and work deal.

4) Designing and Planning: This designing and planning stage are related to work planning, tools, and material preparation, setting time and division of work task. Students must be trained to have mature planning habits. Work planning is based to make every action success. Product understanding that accordance to agreement that has been established in the employment contract is very important. Therefore, designing and planning stages are very needed, so there is discussion that conducted by study groups that have been formed. In this stage, students also are instructed to arrange the steps of making products, so they have a guideline for work. Lecturer as planning consultant, due to students can make work planning well.

5) Product Manufacturing: Product manufacturing process has to accordance to the work steps that have been designed. Machine and tool using have to accordance to Standard Operational Procedure (SOP). Lecturer in this stage as supervising the execution of product work. Supervision that conducted by lecturer is important to control quality of product. Supervision of machine and tool using is also important to maintain students' safety.

6) Final Product: Final product that has been created by students is evaluated in together by lecturer and students before it is turned over to consumer or promoted in the website. This final product stage is conducted by product presentation in the class seminar. According to the employment contract, comments and suggestions toward product can be evaluation of product conducted by students.

7) E-commerce: Effective product marketing on the 21st century is using website. Many online stores successfully market their products through this online system. Consumers who ordered the product are posted in the portfolio, so it will teach successful promotion and make new consumer interests to order the products. Products of market analysis are promoted and sold in online using e-commerce which applied on the website. Product (students' practice task) conducted based on consumer demand is also displayed in the website (e-commerce) as teaching factory activity portfolio.

The social system in the development of the Teaching Factory IR 4.0 learning model can be interpreted as a system that consists of a set of actions where interactions occur between one individual and another and always grows and develops in a learning environment. As has been explained that the Teaching FactoryIR 4.0 learning model is a development of the project-based learning, production-based learning, and teaching factory approaches which contain several things that can be viewed as learning characteristics which include; a) market potential and project-based assignment themes, b) students are formed in groups, c) use job sheets and LMS.

The practicality test data for the Teaching Factory IR 4.0 model on the distribution system course was collected from a questionnaire that has been distributed to lecturers and students.

TABLE III
PRACTICALITY ANALYSIS RESULT OF TEACHING FACTORY IR 4.0 MODEL

No	Respondent	Percentage (%)	Category
1	Lecturer	88.75	Very practical
2	Students	83.56	Very practical
Average		86.16	Very practical

Based on Table 3, the practicality of the Teaching Factory IR 4.0 model is based on the responses of students and lecturers through questionnaires. The average percentage of the assessment from lecturers was 88.75% and students were 83.56% in the very practical category. The overall average result is 86.16% with the very practical category. These results indicate that the very practical category developed can make it easier for students to understand the material.

The effectiveness of the Teaching Factory IR 4.0 model in this study was seen from the ability of the model to activate students in learning and make it easier to understand and carry out learning. In this assessment, the Teaching Factory IR 4.0 model's effectiveness in terms of student learning outcomes. Learning outcome tests are used to determine the effectiveness of the learning process. Learning outcomes are abilities that students have after they go through the learning experience process. Learning experiences in the form of learning activities that are effective and can realize the goals of good learning outcomes. The purpose of assessing learning outcomes is to measure the success rate of the teaching and learning process that has been implemented.

The description above shows that the use of the Teaching Factory IR 4.0 model developed makes it easier for students to understand the material so that student learning outcomes are better. Evaluation is the process of determining the extent to which the learning process has been achieved [20], [21]. The learning outcomes for the distribution system's practical learning show that of the 20 students who took the test before they used the Teaching Factory IR 4.0 model, they had an average learning outcome of 60, which was quite effective.

Based on the learning outcome data from 20 students who took the test after they used the Teaching Factory IR 4.0 model, they had an average learning outcome of 80.38, this is in the very effective category. This shows that there is an increase in student learning outcomes before using the model and after using the Teaching Factory IR 4.0 model. So, it can be concluded that learning using the Teaching Factory IR 4.0 model can be said to be effective in improving student learning outcomes.

This teaching factory 4.0 model has two impacts, namely the instructional impact and the accompaniment impact. The instructional impact of this learning model includes: understanding of concepts, the ability to apply concepts in solving problems, the ability to respond, ask and answer questions, pay attention to lecturers' explanations, and assess phenomena that occur, and the ability to socialize. There are 3 functions of motivation, as followsl:

- Encouraging humans to act, driving force, or a motor that releases energy. Motivation in this case is the driving force of any activity to be carried out
- Determining the direction of the action, namely towards the goal to be achieved. Thus, motivation can provide direction and activities that must be carried out according to the formulated goals
- Selecting actions, namely determining what actions must be carried out in harmony to achieve the goal, by setting aside actions that are not useful for that goal. For example, a student who is about to face an exam with the hope of passing it will certainly carry out learning activities and will not spend his time playing cards, reading comics, because it is not in line with his goals.

In addition, there is another function of motivation, namely as a driving force for business and achievement. Someone does an effort because of motivation. The existence of good motivation in learning will also show good results, or in other words, the motivation intensity of a student will greatly determine the level of their achievement.

Factors affecting learning motivation have types of motivation that affect student learning, including everyone's

urge to do something. Intrinsic motivation is said to be a form of motivation in which learning activities are started and continued based on an inner impulse and are related to their learning activities. This motivation is also called pure motivation. The other is extrinsic motivation Extrinsic motivation is motives that are active and function because of external stimuli. This motivation is a form of motivation in which learning activities are started and continued based on an external push that is absolutely related to learning activities. Extrinsic motivation arises from external influences [7].

This learning model's accompanying impacts include increase learning motivation because students are actively involved in the learning process. There are five reasons why motivation is a very complex process, as follows:

- The motive that causes a person's actions cannot be observed but only predicted
- Individuals have needs or expectations that are constantly changing and sustainable
- Man satisfies his needs in various ways
- Satisfaction in a particular need can lead to an increase in the intensity of needs
- Behavior that leads to goals, does not always result in satisfaction.

Learning is a collection of people who are active in activities. There is a sense of mutual respect and respect for differences, self-confidence, a conducive learning atmosphere and openness, making mistakes, and joint and own evaluation [22]. Independent learning in the learning process, it is necessary to provide opportunities for students to develop a spirit of healthy competition to gain appreciation, cooperation, and solidarity [22]. Independent learning can also mean learning that is not dependent on other people, self-confidence, and responsibility. Apart from that, it was also stated that in independent learning it is necessary to have assignments that allow students to work independently. Independent learning can be obtained through other sources, places, facilities, and environments.

Independence is defined as an individual's internal strength and is obtained through a process of individuation, which is a process of self-realization and a process towards perfection [15]. Independence is the ability to direct and control oneself in thinking and acting, and not feeling emotionally dependent on others. In essence, an independent person is able to work alone, be responsible, confident, and not dependent on others [23].

The independence in its development are divided into 4 levels, i.e. the level of self-awareness, level of care, individuality, and independence. The characteristics at the independent level are having a view of life, being objective and realistic, integrating conflicting values, resolving conflicts, having the awareness to respect and acknowledging interdependence on others , and having the confidence and joy to express their feelings [4].

Creativity is a person's ability to produce something new, both in the form of ideas and real works that are relatively different from what already exists [3]. Creativity is a high-level thinking ability that implements an escalation in thinking skills, characterized by success, discontinuity, differentiation, and integration between developmental stages. Creativity is the ability to create or inventiveness, creativity can also mean the latest and original creations created, because creativity is a unique mental process to produce something new, different from the original. Creativity is an organized, comprehensive, imaginative brain activity leading to an original result.

Creativity is the ability to provide new ideas and apply them in problem solving. Creativity is the ability to produce forms in art, or, in machinery, or solve problems with new methods [3]. Creativity is the ability to make new combinations, based on existing data, information, or elements. Creativity is an experience in expressing and actualizing an individual's identity in an integrated form between the relationship between oneself, nature, and others.

IV. CONCLUSIONS

A New Teaching Factory model that was developed was combined with three models: based learning, production-based learning, and Teaching Factory, and learning implementation, which was conducted by hybrid (face-to-face learning and distance learning). Hybrid learning used LMS as characterizes of 21st century learning. A New Syntax Teaching Factory model consists of seven learning stages, are follows: product analysis, work team formation, work deal, designing and planning, product manufacturing, final product, and e-commerce. This study's implication was contributing reference of Teaching Factory learning model that relevant to revolution industry 4.0 today. The effect and empirical review of a new teaching factory have not been studied yet through this study. So, we invite vocational education learning and teaching researchers, professors, and educators to conduct the implementation study and describe A New Syntax model's effect. The real effect of model implementation is expected to be shown, so it be able to guidelines in the further syntax development to create the effective learning model.

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