Four Pillar Teaching Factory: A Teaching and Learning Management Model In Technical and Vocational Senior High School

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***Abstract*—The purpose of this study is to explore deeply teaching factory at Technical and Vocational High School. Teaching factory is the best method of teaching and learning to integrate and to bridge the process of achieving competences of the students and required skills needed by the industrial company. This unique four pillars teaching factory consist of four components, that interconnected for each other, namely block schedule, physical product, job sheet, and corporate culture. This study used the qualitative approach with case study method. Data was collected through in-depth interviews, observation, participant observation, and documentation of the research informants comprising the school principal, vice-principal of curriculum and instruction, head expertise program. The data collected was analyzed through the process of data condensation, data display, and conclusion drawing/verification. The result of the research show that Catholic Technical High School of St. Michael Surakarta has his own unique teaching factory with certain management in order to enrich the students with competences so that they will be ready to work in the industrial company. It is expected that this research would be a meaningful reference for the relevant researchers, and educational practitioner who wants to develop the technical or vocational education.**

Keywords— management; teaching factory; technical senior high school

I. INTRODUCTION

Technical and vocational school is deemed secondary education that particularly prepares students to work in certain fields. Technical and vocational graduates are middle-level workers who have adequate skills or competencies in accordance with the demands of the times, and are ready to work in the business and industry world. The main learning goal of vocational high school is to prepare students to become successful employment in the labor market [1]. The vocational high school students are prepared both for life and livelihood.

Technical senior high schools or vocational schools cope with various major challenges, namely (1) the skills and expertise of vocational graduates that are still low and mismatch with the skPills demanded by the market or the business and industry world, (2) curriculum and instruction have fallen short of proper synergy involving the business world due to the absence of collaboration between the two. The teacher only gives information in front of the class while the students just listen passively during the teaching and learning activities [2]. Innovation in vocational school learning will not occur without the support of teachers who have experiences, knowledge, competence, and extensive networks with industry [3]. It is no wonder to note that vocational school graduates who should have been ready to work actually increase the number of unemployment instead.

Considering these conditions, technical and vocational education must systematically and integrally revitalize itself through learning teaching factory or learning factory, that is by "learning" in a "factory" environment [4]. This school revitalization involves the objectives, processes, and assessments of teaching and learning activities such as in industrial settings, which is "in close-to-reality industrial settings" [5]. Teaching factory in vocational schools is not just deemed a production unit in schools as reckoned by many vocational school teachers.

Technical and vocational schools must be managed as educational places as well as industries aiming at preparing students with various competencies: professional, methodological, social and personal, [6] to go into the business and the industrial worlds. With the teaching factory concept or learning factory, students and companies will experience learning environments and student competencies that are suitable for improvement of work productivity. Students will then have capabilities to bring and apply various theories into the real work environment. [7]

II. LITERATURE REVIEW

Some researchers presented a concept of teaching or learning factory which has been formulated in the CIRP Encyclopedia of Production Engineering as follows [8]. Teaching factory is a locus or learning environment which consists of an authentic process, covering many sections, and consists of technical and organizational aspects, settings that can change, physical products produced, and the concept of teaching (didactic) in the form of formal learning through classroom teaching and workshops. In accordance with its purpose, teaching factory is materialized in the form of teaching, and as a result, generates learning outcomes in the form of competence development and /or competency innovation.

Teaching factory or learning factory creates a realistic learning workshop in which students have the opportunity to apply the development process and at the same time directly produce the physical product. A learning factory is a realistic model of a production environment that offers learners the opportunity to implement process improvements and to see the results immediately. Its main purpose is to provide engineering students with practical hands-on experience through real-life projects. [9]

In the technical and vocational schools, teaching factory is managed as learning that has synergy with business and industrial worlds to produce graduates with competencies demanded by the market needs. Through this teaching factory, students get the knowledge and skills which are required to work out their jobs successfully and effectively. In other words, one of the teaching factory goals is to enhance students to develop their competence in transferring or applying their learned knowledge into practical situations for problem solving or job completion. [10]

Teaching factory will produce competent students, namely graduates who have qualified capability to apply knowledge, skills and attitudes to achieve observable results [11]. In short, certain knowledge, skills and abilities or so-called competencies or employability skills, can be developed through teaching factory. [12]

Teaching factory is a learning method that integrates the educational environment and the industrial environment, "Learning in a Factory Environment", [13][4] implements a factory to school, "factory-to-classroom" or transfers a real production environment to the classroom. This learning method provides real and relevant learning experiences that produce students who are competent on knowledge, skills and attitude. A competent person is a student who has knowledge of a field of work or field of study who shows the ability to apply knowledge, skills, attitudes [11] and proficiency. He or she can use them to complete their works and solve problems [14].

As a learning method, the teaching factory is used to bridge the needs of the business and the industrial worlds and the skills or competencies of students in school. Teaching or learning factory is a very important concept of learning because it will enable companies or schools and students to adapt themselves to the learning environment while developing the required competencies to increase work productivity [7]. Students work on or produce items as it is the case in industry. Thus, students can immediately put theory into a real working environment while developing their knowledge and competence.

In the so-called 4.0 industry era, technical and vocational schools must apply the teaching factory to create innovations in terms of learning and school management. The school principal as a top manager who is responsible for the work of other people [15] should manage the teaching factory by applying management functions which include planning, organizing, leading and controlling the utilization of various resources to achieve the goals set by the school organization.[16].

III. RESEARCH METHODS

This study uses a qualitative approach which is applied to the case study method. The researcher conducts detailed and in-depth exploration using the basic question of how and why teaching factory is practiced at Catholic Technical Senior High School of St. Michael Surakarta which at the end successfully produces competent graduates who are ready to go into the business and industrial worlds. This school has various excellences, achievements and uniqueness so the school gains credibility to assist many vocational schools in Indonesia to develop their teaching factories.

Having successfully found the focus and sub-focus of the problem through the grand tour observation, the researcher conducted the study for one year with various methods such as direct observation, participatory observation, interviews, archival recordings, and documentation studies. In this study, by using an unstructured interview, the researcher conducted comprehensive explorations of teaching factory with the four components or pillars and why they applied the teaching factory. Furthermore, with the structured interview method, the researcher explored the teaching factory management from the principal, vice principal, the head of the expertise program, and productive teachers who directly involved in the teaching factory management. The data collected through interviews, observations, and documentation are analyzed using data condensation, data display, drawing and verifying conclusions. [17]

IV. RESEARCH FINDINGS

From the data collection activities which were conducted through some methods such as direct observation, participatory observation, interviews, archive recordings, and documentation studies, [18] the study identifies the following findings.

A. Four Pillar Teaching Factory

Based on the results of interviews and observations, the teachers have applied teaching factory as a learning method that integrates educational and industrial processes so as to create students who have knowledge, expertise and attitude competence. The teachers formerly called this learning method as Production-Based Education and Training. The

most senior informant at this school provided the following statement.

> As a learning method, teaching factory, which we formerly called the production-based education and training, is used as a way to connect the needs of the industry and the competence of students in school. Practices done at school are made up as if done at the industry. Physical products made by the students should meet the quality and tolerance required by industry. The school culture is similarly developed as that is in the industrial culture. Students who graduate from this school have been accustomed to industry and ready to work.

Based on some interviews and participatory observations conducted by the researcher, the teaching factory developed in this school has four pillars or main components, namely the block schedule, physical product, job sheet and corporate culture, as said by a senior informant as follows.

> One of the obviously seen from the teaching factory is the fact that the schedule uses a block system, the job sheet is product-based, the product is real , and the corporate culture is perceptible . Corporate culture is transformed into discipline, honest, transparent, responsible way of behaving.

Pillar 1. Block Schedule

Block scheduling system is applicable to the management of process and cycle of teaching and learning activities so that students have learning session for certain competence enhancement which is accompanied by the teacher. An informant gave the following statement:

> To ensure that students have competence, teaching and learning activities are arranged in a block system in such a way that students have maximum learning time and optimal mentoring when learning a particular competence. It implies that every student utilizes one practical tool (one student, one tool) during work practice. This practice is done continuously and repeatedly over a certain period of time depending on the skill competency being studied. For example, a practice might be done for 1-2 consecutive weeks.

This teaching-and-learning schedule is intended to provide sequential and uninterrupted practical learning within a certain period of time to ensure that students reach the expected competencies or meet the quality standards. By setting this kind of schedule, all facilities are constantly used in effective way. This means that during work practice, each student uses one practical tool (one student, one tool). The purpose of using the block schedule is confirmed by the following informant.

> The prominence of teaching factory lies in uninterrupted or continuous learning practices until they reach the competence that meets the quality standards. Physical product as a result of practice training must be useful and saleable to the market. All facilities are constantly used effectively. The workshop cannot stop because three academic areas: knowledge, skills and attitude, should be taught there.

Pillar 2. Physical Products

Physical products are deemed learning media that deliver students' competencies to achieve competence that meets a certain quality standard. The products resulted by the practical training must be useful, because they are produced from the continuous and simultaneous utilization of all facilities.

Therefore, there are two aspects that must be considered in determining a physical product, namely: (1) the number of competencies that can be delivered through the physical product, and (2) the quality standard and value of the physical product that meet the internal needs of the school or worth selling on the market. This was confirmed by an informant through the following response.

> Teaching factory focuses on the student competence. The characteristic of the teaching factory is in the practice schedule which uses the block system and there are products that deliver student competencies through the learning process. Physical products as a result of practical training should meet the standards and are useful, while continuously using all facilities effectively.

Pillar 3. Job Sheet

To achieve competence and at the same time produce physical products, each student needs a job sheet to work on practical objects. In the participatory observation, when become a trainee like the students of this school, the researcher concedes the importance of job sheet during the completion of a physical product. Job sheet contains stages of activities which guide students to gain effective performance. It implies that students must not make any mistake, objects are not wasted, and the machines keep running efficiently.

Job sheets are derived from the Learning Implementation Plan which leads to students' competencies while simultaneously producing physical products. Therefore, the job sheet must be arranged in harmony with the physical product and the previously-constituted block schedule. This was stated by an informant as follows.

> Job sheet is part of the Learning Implementation Plan which contains a sequence of materials which lead to students' competencies together with the final result in the form of products. Therefore, the job sheet must be arranged in harmony with the

product and the block schedule that has been determined previously.

Pillar 4. Corporate Culture

During one year research, the researcher found and conceded a very compelling school culture which then turned to be the distinctive identity of the school and its graduates. School culture as the core values are competence, conscience, and compassion, which liven up every school community member and mark the distinctive characteristic of the school.

In addition, there are some values embraced and instilled by the students during the learning process that establish an industrial culture in the school. Corporate culture is deemed integral parts among the other three pillars or teaching factory components, namely block schedule, physical products, and job sheet. The dominant corporate culture at school are:

1) a culture of discipline with full and timely attendance supported by a compensation system; discipline is an important capital for a change and progress achievement;

2) honest culture that is enforced by imposing a drop-out system only if students commit thievery or other forms of dishonesty;

3) a culture of responsibility that is supported by applying a coin system in borrowing work tools, responsible for machinery, work tools and their cleanliness;

4) a culture of persistence, precision, and accuracy by standing for hours working on work pieces in the work bench with caliper measuring instruments and others ready anytime;

5) transparent culture that is upheld by doing collaborative assessment of work objects involving the practice teacher and the students while engaging a dialogue on the challenges and difficulties during the process of product completion;

6) a procedure-compliant culture that is shown by working on everything or operating a machine based on the given procedures and the previously-set preparatory work steps.

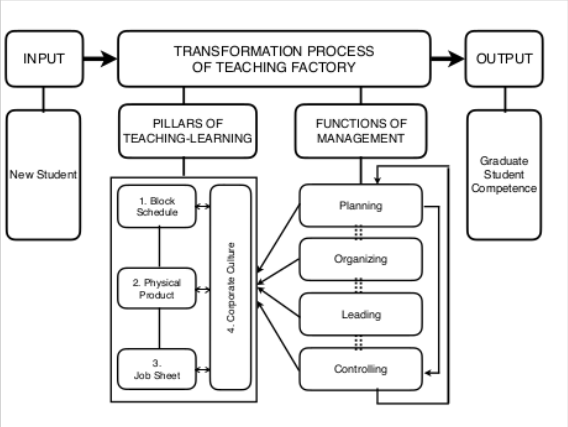

Figure 1. Transformation Process of Teaching Factory

B. Teaching Factory Management

Based on the teaching factory concept and its fundamental pillars, and management and its functions, it can be synthesized that management of teaching factory is the activity of setting teaching factory learning goals, planning clear steps to achieve these goals, by managing the available resources in school and distributing assignment so as to run effective and efficient learning, as well as controlling through monitoring and evaluating the course of learning process based on the vision and mission of the school [19](fig. 1).

In this study, the researcher used the following mind mapping and research flow. Teaching factory at Technical and Vocational High School is teaching and learning activities and learning management that run all together. The principal as the top manager in the school manages this learning and teaching process through the teaching factory management which consists of 4 interconnecting pillars while performing the functions of planning, organizing, leading, and controlling [20] the pillars of the teaching factory. The purpose of this teaching factory management is to improve students' competencies so that they are ready to work in the business and industry worlds.

In teaching factory planning, the school principal (top manager) assigns duties and authority to the vice principal of the curriculum division (middle manager) and the head of the expertise program (first-line manager) to coordinate and collaborate in developing block schedules, determining physical products and arranging jobs sheet, to build industrial culture at schools.

The teaching factory learning is intended to improve the ability or competence of each student optimally by (1) regulating the rotation system of theoretical and practical learning activities, (2) regulating the use of practical learning facilities so they can be continuously and simultaneously used as the scheduled time, (3) producing useful and saleable physical product, and (4) creating an industrial culture at school.

Before starting the new school year, the school principal runs the organizing teaching factory function by arranging the organizational structure and job description, selecting people and simultaneously organizing tasks that enable them to coordinate and communicate in arranging block schedules, determining physical products, arranging jobs sheet, instilling the values that shape corporate culture.

The objectives to achieve in organizing the teaching factory pillars are as follows:

1) regulating the continuity of learning process to achieve the competence of each student;

2) harmonizing learning culture at school with industrial culture;

3) optimizing the use of practice facilities in the learning process by allotting one week of theory, one week of practice;

4) optimizing the existing resources at school, namely students, educators, facilities and infrastructures, finance and others, so as to run more effective and efficient teaching-learning process.

The school principal always communicates and coordinates with his staffs, the theory and practice teachers. This coordination allows staffs and teachers to communicate and cooperate with each other in utilizing the existing resources at school. By doing so, the teaching-learning process is carried out more effectively and efficiently and thus, at the end, each student has the competencies required by labor market and industry.

The controlling function of teaching factory aims to ensure that teaching factory learning process can run according to the plan:

1) Does the learning process proceed continuously and simultaneously?

2) Are all learning equipment and facilities optimally utilized?

3) Can the block schedule create an industrial culture at school?

4) Can the practice teacher teach and provide assistance to each participant to achieve their competence effectively and efficiently?

The teaching factory control is carried out by monitoring and evaluating the course of learning process in accordance with the block schedule that was set a year before, physical products that have been completed by students, job sheets that guide students' performance, and corporate culture formed by the other three pillars.

Monitoring is carried out by the school principal, vice principal, staff, and all teachers during the learning process in the workshop. The vice principal for the curriculum division assigns the head of the expertise program as well as the head of the production unit along with the practice teachers to run practical learning, mentoring and providing personal mentoring to each student during the learning activities.

Monitoring teaching-learning activities is carried out by directly supervising students who are working on their work pieces on their machines according to the job sheet guidelines, starting from attending on time up to leaving the workshop.

Evaluation of teaching factory learning is routinely conducted by doing as follows.

1) Assessment of work piece. Upon completion of the work piece, the practice teacher applies joint assessment involving the students transparently. This is deemed objective assessment with reference to the quality standards stipulated by the job sheet. In addition, the teacher also engages dialogues and discussions with the students on their experiences and challenges during the completion of their work pieces. The teacher should provide a solution as long as possible.

2) Evaluation of Curriculum and Instruction Unit. The Vice principal for curriculum division together with the head of the expertise program and all the practice teachers organize regular evaluations of the block schedule, job sheets, and physical product, and the attitudes of students during the teaching and learning process at the end of every semester.

3) Management Review. Management Review is held at the end of school year every June. In this event, the school principal together with the teachers evaluate the course of the teaching and learning process in the past year. Various problems are solved together while preparing the upcoming school year.

V. Discussion of Research Findings

Based on the aforementioned results of the qualitative research here, the researcher discusses the findings to answer the question why and how the 4 pillar teaching factory in Technical and Vocational Senior High School improve students' competencies so that they are ready to work in the business world and the industrial world.

A. *The purpose of teaching factory learning at the Technical and Vocational Senior High School is to enable each student to develop their competence in transferring or applying their learned knowledge into practical situations or in a real industrial environment. This is in consistent with the results of teaching factory research conducted in other countries which states that one of the main objectives of teaching factory is to enable students to develop their competence to transfer knowledge that has been learned into practical situations. [10]*

B. *Teaching factory is arranged in school workshops through competency stages ranging from bench work, filing, welding, turning and milling. Every learning process in each section which will achieve student competencies always produces a physical product. The production learning process done in the factory is brought into classrooms or schools. This is in line with the statement of Ogorodnyk et al. that said, "Running the activity in the real-world assembly brought into the classroom the process of being held in the real world". [21]*

C. *The head of the expertise program together with the teachers selects the physical product to deliver student competencies. The more the student competencies delivered, the better the product will be. These findings are in line with the research results conducted by many researchers and practitioners of teaching factory. For teaching purposes, the teacher might select the product needed by the school, accept orders, or sort out physical products that are saleable to market but still in compliance with the standards [4]. Physical products are produced by the students who meet competency standards, as stated by the practitioner of learning factory, Gunther Schuh et al., as saying that there must be a cycle of real production process in learning factory.*

D. Modern organizations such as schools have an organizational structure consisting of bureaucratic expectations and roles, a hierarchy of position, rules and regulations, and specialization.[23] The school principal, vice principal, and head of expertise program should be creative in learning management of teaching factory so that student competencies can be achieved in progressive and integral way. As a formal education unit, Technical and Vocational High School provides education for three years in accordance with the government curriculum. In grade X, students should master the basic competencies and sense of quality of industrial products. In grade XI, students are trained to be competent so as to have a sense of efficiency in industrial products and thus the products should be good, correct, neat and saleable to the market. In grade XII, every student is trained and encouraged to have a sense of creativity and innovation. The teacher provides guidance to the students through project work which demands every student to create various innovations creatively through physical products, have problem solving capability, and be able to capture new opportunities. In short, the purpose of the teaching factory is to encourage technological and organizational innovation while developing students' competencies effectively. [24]

VI. CONCLUSION

To produce competent graduates on engineering, planning and design of machinery, Technical and Vocational High School should develop a so-called four pillars teaching factory covering: block schedule, physical product, job sheets, and corporate culture. These four pillars are managed by the school principal and his staffs through some management functions: planning, organizing, leading, and controlling, in the effort to create effective and efficient learning which will improve the competence of students who are ready to move into the business and industrial worlds, while producing advantageous and saleable products to meet the market demand.

Acknowledgment

It is expected that this research will serve as the meaningful reference for relevant researchers, stakeholders, and educational practitioners who want to develop the technical or vocational education.

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