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Bridging the Skills Gap Through Teaching Factory (TEFA)

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***Abstract*—In most developing countries the vocational curricula are still lagging behind in terms of linkage and matching with skills needed by the industry. Teaching factory is a suitable learning and training model that can produce graduates who are competent with industry desirable skills. Teaching factory has great potential to narrow or close the skills gap. The purpose of this study was to determine the potential of teaching factory to produce competent graduates. The observation done in some vocational schools (SMKs) in Bandung revealed that learning was done under industry conditions but shortages of training infrastructure was slowing down the training processes. All the schools used a block time table in which grouped students rotate between theory and practice. The government should increase the infrastructure budget for the vocational schools (SMKs) and also help schools to mobilize capital development funds.**

***Keywords*—teaching Factory, skills gap, SMKs, vocational education**

I. Introduction

A. Skill Demand in Indonesia

In Indonesia, high unemployment is partly attributable to the inability of educational institutions to timeously respond to industry demand for employable skills, that is, a fraction of the unemployment is due to skills gap. There is always emergence of new skills needed by industry, and there is need for some stakeholders to address the emerging skills deficiencies. However, the real challenges in Indonesia lies on the inability of employers as skill demander, educators, policy makers, civil society groups and other relevant stakeholders to cooperate [1]. In Indonesia, another problem encountered in an attempt to address the skills gap is the lack of adequate funding. Huge sums of funds are needed to purchase the necessary training equipment, for curriculum making process to mention a few. One way of training graduates who possess skills needed by industry is to implement the dual system of training, but in the context of Indonesia, the industry does not have the capacity to absorb all the vocational trainees/students in vocational schools (SMKs) [2]. In Germany, dual system trainees spend 8–12 hours per week at school, and the remaining time is spent at the actual worksite [2]. The teaching factory learning model is suitable for Indonesia considering the size of vocational education in Indonesia, although huge capital investments are needed.

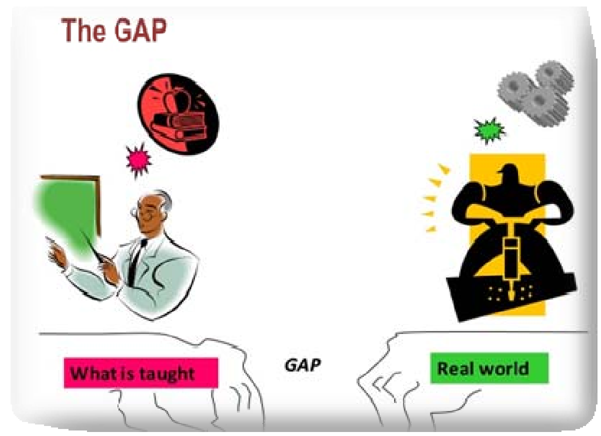

Fig. 1. Skills gap illustration

B. Curriculum Development and Review

Curriculum developers should forecast what kind of competency skills will be available in 6-8 years' time that is the time evolving between identifying a new need, designing a new course, delivering it and students leaving with a certificate. It is an extremely difficult task in an ever changing and fluctuating economy. Furthermore, forecasting exact skills needed in 5 years' time is not a demanding task [3]. The curriculum should be constantly reviewed and necessary adjustments should be made in line with changes that will be taking place in industry. This is an extremely costly and it is tedious to implement the curriculum adjustments. The obsoleteness of skills due to the impact of new technology implies that the teachers or trainer must also constantly upgrade themselves through industrial training programs [4]. Curriculum changes affect all stakeholders involved in the training process.

C. Closing Skills Gap Through Teaching Factory (TEFA)

The production industry is increasingly demanding workers and engineers who understand or with capabilities to operate latest production systems [5]. According to the IMF, at least 28% of Europe's GDP was contributed by the manufacturing sector in 2013 amidst severe financial crisis that paralyzed most economies [6]. This implies that for the contribution of the manufacturing sector to keep on increasing, vocational education must speak the same language with industry through teaching factory operations. There must be harmonization of production technologies used in industry and the study of their usage in the classroom [5].

Many researchers revealed the critical relationship between the quality of education and economic growth [5]. A survey conducted in Europe by the Mechanical Engineering Association predicted a skill shortages and skill gap if vocational education does not up its game on training what is needed by the industries [7]. Teaching Factory (TEFA) brings trainees closer to the industrial context and trainees are afforded an opportunity to research solutions needed by the world of work through industrial projects. In teaching factory, simulations can be incentivized in an academic setting using model production equipment [8]. However, teaching factory equipment might be rendered obsolete because of the rapidly evolving production systems [8]. This means that there is the need to rapidly modify or replace outdated equipments. TEFA modernizes the teaching process and brings it closer to the industrial practices, leverage industrial practices through knowledge and establish as well as maintaining industrial growth [5].

D. Teaching factory concept

The teaching factory is a medical sciences concept which was first used to close the gap between skills needed by the industry and what was taught in the classroom. In this paradigm, teaching hospitals or medical schools could operate parallel with hospitals [9]. The teaching factory is still practiced up to now in medical schools. Teaching factory brings the learning and working environment together out of which realistic and relevant learning experiences emerge. There is knowledge triangulation between education, research and innovation.

Fig. 2. Skills gap illustration

In the teaching factory curriculum, knowledge transfer is two way. The knowledge transfer media are used for the delivery of learning materials and suggested problem solutions by the students [9]. Two way knowledge transfers are factory-to-classroom and academia-to-industry. The media for delivering knowledge include live or recorded videos, augmented videos and slides to name a few. The configuration layout of the factory-to-classroom concept should follow a modular approach to allow flexibility on its application and operation [10].

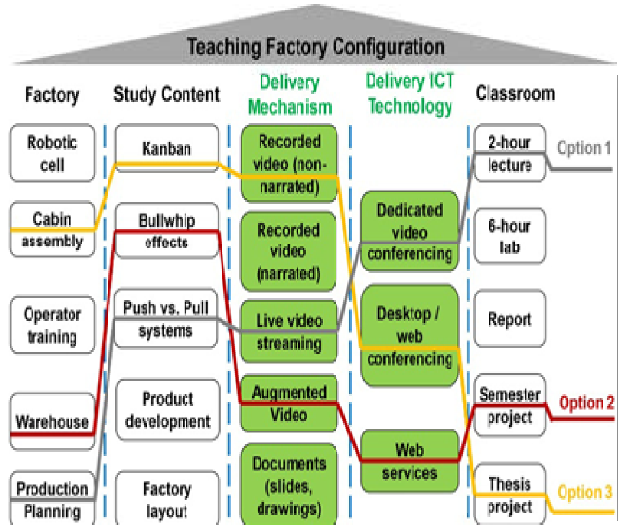

Fig. 3. Skills gap illustration

The operations from the factory might be virtually presented in the classroom, laboratory or conference room. In Indonesia, engineers or trainers visit schools to engage in live training. Engineers will make presentations pertaining industrial projects while the students listen in the classroom. In live presentations students may actively participate. They may also conduct online seminars and assign students problems to be solved through collaborations.

The school to industry delivery mechanism transmits the knowledge from the school to the industry. The students transfer new discoveries that can be used to train or retrain operators on new production technologies. A teaching factory curriculum if well-designed can close the skill gap between industry and vocational education and could be highly beneficial to the industry as a research cost cutting measure in that there will be no need to retest discovered innovations. In Indonesia, teaching factory is currently being implemented in technical courses.

E. Purpose of the Study

The overall purpose of the study was to determine whether the teaching factory (TEFA) learning model is capable of producing high grade graduates who possess employable skills. The researcher was also interested in the capacity of the vocational high schools (SMKs) to implement the TEFA curriculum in an organized way.

II. METHOD

In order to achieve the objectives, the researcher observed the implementation of teaching factory (TEFA) in West Java. The method was chosen because observations serves the purpose of our orientation in the world [11]. The researcher also opted for observations because they are a direct registration of facts and circumstances relevant to the research and they are time saving and cost effective too [12] [13].

A. *Laboratory and Field Observation*

To have an appreciation of TEFA in the SMKs, the researcher visited the workshops and attended vocational theory classes at some SMKs in Bandung. The researcher also carried out laboratory observation in some well-equipped SMKs like SMKN 9 Bandung. Laboratory observation is different from field observation in that it takes place in environments that are suitable for experimentation [12].

a) Data Collection

The researcher assembled information on how the teaching factory classes are organized. The students were divided into small practical groups. The researcher obtained samples of the time tables and weekly students per machine ratio and the rotational theory/practice program. The researcher visited SMKN 9 Bandung, and SMK Telkom Bandung. Most SMKs have a challenge of infrastructure and TEFA is implemented under tight schedule.

III. Result and Discussion

The researcher also observed that the students in technical program were grouped so that they could learn effectively and efficiently. In these groups, each student operated a machine and used the equipment individually.

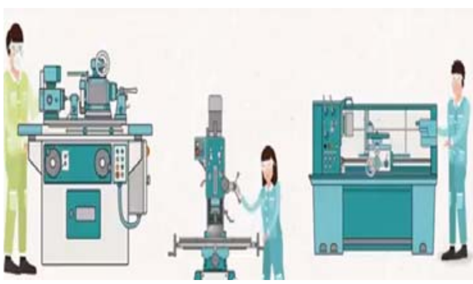

Fig. 4. Individual machine operation by group member

A. *One student per machine*

The researcher found that in Indonesia, each machine was used by more than one student at different times. This is because of limited infrastructure. Some schools also shared laboratories and workshops. During practice time, each student worked on the machine or equipment individually. This gave the student enough time to work with the machine under the instruction of the teacher.

Fig. 5. Individual machine operation by group member

B. *Rotation*

The grouped trainees rotated between theory and practice. Students learned theory in one week and the following week was reserved for practice.

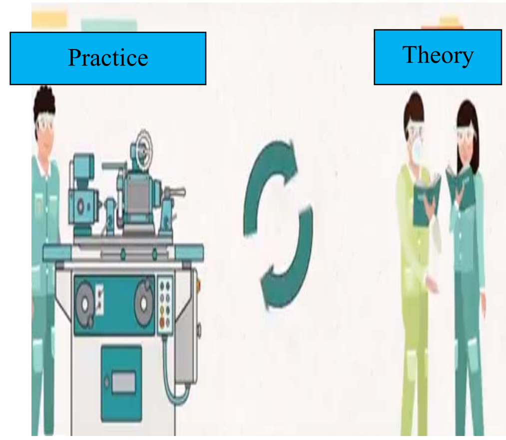

Fig. 6. Individual machine operation by group member

C. *Practice Timetable*

The student practiced different concepts at the same time in their small group as follows. For example in the practical week students (1-4) practiced technical graphics and students (24-28) practiced manual milling. In the second week, the students learned theory. In the third week, the practical time table was varied as shown below. In the time table below weeks 2, 4, 6, 8 were reserved for learning theory that is even numbered weeks.

The timetable was also varied depends on the interests of the vocational school (SMK). In some circumstances, the trainees could learn theory in two consecutive weeks followed by a one week of practice. In some schools they could learn theory in one week and practiced in two weeks.

Semester	1							
Siswa / Minggu ke	1	3	5	7	13	15	17	19
1 - 4	GT	GTM	LW	LW	LW	LW	MILL	MILL
4 - 8	GTM	LW	LW	LW	LW	MILL	MILL	GT
9 - 12	LW	LW	LW	LW	MILL	MILL	GT	GTM
13 - 16	LW	LW	LW	MILL	MILL	GT	GTM	LW
17 - 20	LW	LW	MILL	MILL	GT	GTM	LW	LW
21 - 24	LW	MILL	MILL	GT	GTM	LW	LW	LW
24 - 28	MILL	MILL	GT	GTM	LW	LW	LW	LW
29 - 32	MILL	GT	GTM	LW	LW	LW	LW	MILL

Fig. 7. Practice Timbetable

IV. Conclusion

Teaching factory is highly desirable because of its ability to produce graduates who possess the market demanded skills and/or competencies. It produced quality graduates with employable skills. Teaching factory is a suitable learning model for Indonesia considering the huge number of students who cannot be all absorbed by the industry in a dual system learning model. The government should increase funding of most public schools in order for them to recapitalize, repair, increase enrolment and reduce the weekly student per machine ratio.

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