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Literature Review of The Development of a Green Campus Teaching Factory-Based Learning Model in Vocational Schools in Indonesia

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Abstract

This research is a literature review of developing teaching and learning models in factories developed to create an education system capable of producing industry standard products or services. The literature review method is used in this article, with references adapted to the research results. The discussion presented includes an analysis of vocational education, including the basic philosophy, characteristics, and models of administering vocational education. Furthermore, the development of the teaching factory learning model, which includes Project-Based Learning (PBL) and Work-Based Learning (WBL), understands its development context. A study of the green campus-based teaching factory approach is then reported to determine the factors influencing it. The final section presents potential research and development related to developing a teaching factory to outline potential studies.

Keywords

Teaching Factory; Learning Model; Green Campus; Vocational Education; Higher Education

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1. INTRODUCTION

In this case, Universitas Sebelas Maret (UNS) Surakarta, a leading educator in the vocational field, has collaborated with industry to implement the teaching factory. For example, the Mechanical Engineering Education study program (PTM) collaborates with PT Buma and King Manufacture. Research for spare parts, waste management, renewable energy, skills training, work practices, grants for practicum facilities, and consumables are all part of the collaboration (UNS, 2020a). In addition, the Building Engineering Education study program (PTB) conducted a tracer study of graduate users and obtained results as shown in Table 1. These graduates' tracing is based on their performance as an indicator of the study program's performance. The results show that graduates of the Building Engineering Education study program performed well for the users. However, more research is required regarding implementing the teaching factory as an evaluation material to improve the learning process and the quality of graduates produced.

Table 1. Tracer Study of Building Engineering Education Study Program (PTB) Universitas Sebelas Maret

No.	Type of Ability Graduates	User Response			
		Very good (%)	Good (%)	Fair (%)	Less (%)
1	Integrity (Ethics and Morals)	68,75	31,25	0	0
2	Expertise Based on Field of Science (Professionalism)	65	35	0	0
3	English	40	60	0	0
4	Use of Information Technology	70	30	0	0
5	Communication	60	40	0	0
6	Teamwork	57,5	42,5	0	0
7	Self-development	62,5	37,5	0	0

The teaching factory paradigm has an educational approach relevant to the interaction between the industrial and academic worlds. Tefa aims to be able to communicate both ways between the industrial and academic worlds. The use of applications is presented for communication between academics and actual industry. This paradigm provides a real-life environment in the industry for students and researchers to develop skills and understand the challenges that exist in the industry (Chryssolouris et al., 2016).

The factory's highly automated factory learning module functions as virtual learning. A balance between theory and practice, theoretical contents are applied in a real industrial environment. Workplaces in learning factories can be implemented in a variety of automation scales. Automated systems are integrated into learning plants to map production networks with three sites (Lanza et al., 2015).

Transformation model to change physical infrastructure and didactic structure from production engineering practice to the concept of a learning factory. The proposed transformation is based on the definition of the three pillars (didactic, integration, and engineering), which are a set of characteristics that must be developed to achieve the learning factory. Provide replicable guidelines for gradually implementing a learning factory (Baena et al., 2017).

The gap that has been built is state of the art in the learning factory. The learning plant's motivation, historical background, and didactics are outlined. The existing factory learning approach provided industry and academia with various applications and varied content. State of the art design curriculum factory learning and its use to enhance learning and research (Abele et al., 2017).

The concept developed from a modular learning factory for Industry 4.0, part of a research center with a component demo, application, and training center. The learning factory is based on action learning and social learning principles. It is a place of learning for Industry 4.0 with practical tasks applying technical artifacts such as RFID, additive manufacturing, robots, and digital performance boards (Schallock et al., 2018).

A learning model that can provide vocational high school students with authentic industrial work experience in the manufacturing and production sectors in the same school where they are enrolled. Industry experience in appropriate schools is expected to improve students' competencies and skills. The four-stage research and development methods used include preliminary studies, development, testing, and validation of models. Using qualitative and quantitative analysis techniques produces a six-step teaching factory learning model (Model TF-6M) (Martawijaya, 2012).

A comprehensive framework of environmental footprint, energy footprint, carbon footprint, and water footprint analysis was conducted to understand how the university interacts with the hydrological, energy resource, and climate cycles. The construction of a green campus needs to consider its comprehensive environmental impact. The environmental footprint framework proposed in this paper provides tools for understanding the direct and indirect consumption of water and energy

resources in universities, where more comprehensive information can be obtained. Thus, it can improve strategies for constructing and assessing future green campuses, which consider the relevant water energy implications (Gu et al., 2018).

Building a green campus into a sustainable community provides a positive reference to achieving global SDGs from the perspective of colleges and universities. By the historical path of its development, this paper combines both (SDGs and green campuses) to discuss using campus development as an effective way to achieve SDGs. This leads to quantitative analysis of sustainable development in the discussion of specific cases, assessing a certain level of sustainability of all aspects of campus construction to provide a scientific basis for summarizing the characteristics of its development mode (Zhu & Dewancker, 2020)

Research has been conducted on Sebelas Maret University, one of Indonesia's campuses, concerning water and sanitation, especially related to waste problems. Liquid waste has been a problem for a long time at UNS, where domestic liquid waste originating from settlements around the campus passes through the lake on campus before finally flowing into the Bengawan Solo River (Karsidi et al., 2018)

The environmentally friendly management of the UNS campus is currently focusing on developing the UNS Green Campus program, which is a program that integrates environmental management and protection. This article aims to examine the evolution of a green campus-based teaching factory (TeFa) learning model, specifically in the education study program in Indonesia's vocational field. Developing a green campus for learning model is critical for identifying waste management solutions in practical learning and addressing all issues with the existing campus environment. It is hoped that the results of the analysis can be used to develop a learning model with an environmental management perspective. In this case, universities can use the pilot green campus-based Teaching Factory learning model to support the United Nations Development Program's Sustainable Development Goals (SDGs) (UNDP).

2. METHODS

A systematic literature review (SLR) is a method for finding, assessing, and interpreting all available research relevant to formulating the problem or topic being researched. This literature review aims to obtain a theoretical basis for addressing the topic being discussed and discover relevant theories. The systematic research method of literature review is a structured and methodical approach to identifying, evaluating, and synthesizing relevant literature in a research field (Snyder, 2019). Once a problem-solving procedure has been adopted, the goal of the Systematic Literature Review data analysis technique for researchers is to demonstrate the clinical efficacy of the documented phenomenon. The four stages of a Systematic Literature Review (discussion) include planning (developing review questions and planning methodology), data collection (keyword search, title, and abstract screening, filtering & and assessment, and data extraction), analytical stage (descriptive and thematic analysis), and integration. Facts become more conclusive, complete, and balanced by combining research findings with systematic review techniques and presenting them in the form of actionable messages (policy briefs and policy papers) (Van Klaveren & De Wolf, 2019)

3. FINDINGS AND DISCUSSIONS

Vocational Education

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) developed and implemented education for sustainable development (ESD) from 2005 to 2014. ESD developed four activities: teaching sustainable development, encouraging sustainable development research, developing green schools or campuses, implementing local sustainability support, and engaging with

various international networks (UNESCO, 2012). The United Nations (UN) established 17 sustainable development goals (SDGs) from 2015 to 2030 to help realize this sustainable development. (UNDP, 2015). The central theme of this plan is an integration of 17 Sustainable Development Goals (SDGs) and a balance of three dimensions of sustainable development: economic, social, and environmental. This agenda seeks to carry forward the Millennium Development Goals (MDGs). This plan has received widespread support from stakeholders, including the government, the private sector, academia, and every citizen.

The SDGs related to this study include four points: (1) emphasizing equality in the quality of education and training; (2) maintaining economic growth, increasing economic productivity, and creating decent jobs; (3) building critical infrastructure, increasing industrialization, and encouraging innovation, developing technology, research, and innovation, particularly in developing countries; and (4) reducing the negative environmental impacts of cities, particularly in developing countries (UNDP, 2015). Vocational education prepares students for jobs requiring a diploma or a bachelor's degree. Professional education is education that prepares students for jobs that require specialized skills. The three types of education all aim to prepare students to be skilled and educated for specific jobs.

There are many different names for vocational education, such as career and technical education, vocational and technical education and training, vocational education training, workforce education, integration of technical preparation for vocational and technical education and training in Southeast Asia, and Vocational Education and Training (VET) and Vocational and Technical Education (VTE) in Australia (MacKenzie & Polvere, 2009). According to Prosser and Quigley (1950), vocational education teaches thinking habits and works through repeated training. Three habits must be taught: adapting to the work environment, doing work habits, and thinking habits. Vocational education also has three principles: education, training, and retraining under the supervision of stakeholders or specific educational institutions.

Development refers to development education after the MDGs were completed in 2015. It is now time to reconsider the role of VET in development from a theoretical standpoint. The VET is being developed using an outdated development model. The most recent trend in VET incorporation refers to development by investigating three theoretical approaches: human rights, capabilities, and integrated human development. (McGrath, 2012). In this context, vocational education refers to education and training that can raise worker status while increasing competence and productivity. Vocational education is intended to improve workers' skills, abilities, understanding, attitudes, work habits, and appreciation to carry out work and make meaningful and productive progress. (Axmann et al., 2015).

Characteristics of Vocational Education

According to the characteristics of vocational education, Finch & Crunkilton (1984) can be used as a reference in the development of the vocational education curriculum in Indonesia, where the developed vocational education curriculum should refer to characteristics such as (1) vocational education is directed at preparing students to enter the workforce; (2) vocational education is based on the needs of the world of work; and (3) the focus of vocational education content is emphasized on the mastery of required knowledge, skills, attitudes, and values. (4) the actual assessment of student success must be on "hands-on" or performance in the world of work; (5) a close relationship with the world of work is the key to the success of vocational education; (6) good vocational education is responsive and anticipatory to technological advances; (7) vocational education emphasizes "learning by doing"; and (8) vocational education requires state-of-the-art facilities for practice by demand.

Implementation Models of Vocational Education

According to the existing model of vocational education in Indonesia Directorate of Vocational High School Development (2015) is:

a. The dual system implementation model, which: (a) Vocational High School implements a

synchronized curriculum system with the industrial or business world; (b) sending students to follow industrial practice for three months; (c) competency tests conducted by industry and or professional or professional certification bodies.

b. The business unit implementation model, where educational or vocational institutions establish business units within schools in cooperatives or industries, encourages the learning process. The school can produce products as goods or services in the business unit.

c. The teaching Industry implementation model, where vocational education institutions collaborate with industry, provides a place or space for production.

d. The Teaching Factory (TeFa) implementation model is one in which vocational education institutions collaborate with industry interactively and openly between schools and industry, partnerships in prototyping, technology transfer, workforce, management, products, and product marketing.

On the other Cedefop (2011) states that the learning experience of students that can be obtained from educational institutions is an important aspect with the consideration that (1) every individual involved in learning can acquire skills and knowledge and can increase the capacity of students, which in theory allows the decision-making process for various aspects of their life such as health, family, community involvement, and social participation to be more efficient; (2) in the context of learning, students in vocational education institutions can form new social groups, modify previous social media, and form relationships with teachers or instructors; and (3) positive learning experiences can be used as potentials to overcome social structure gaps.

Teaching Factory Learning Model

According to Chryssolouris et al. (2016), A teaching factory is useful for two-way communication between academics and practitioners in the industry. The industrial world has its personality and nuances regarding the educational process and learning outcomes. As a result, higher education institutions in the learning process must be capable of developing appropriate learning approaches and responding to the wants and needs of the industrial world. One appropriate educational model is to align the learning process in higher education with the work process in the workplace. The Teaching Factory (TeFa) program approach is a hybrid of Competency-Based Training (CBT) learning approaches in which training is based on the work done by students at work. It emphasizes what someone can do as a result of training (output) rather than what they can do as a result of training (input). The quantity of the training amount (Henri et al., 2017). Production-based training (PBT) is a method of learning skills and abilities designed and implemented by procedures and objective work standards (real jobs) to produce goods and services in response to market demands.

The teaching factory concept approach can be realized in learning to improve applied competence in real situations by using teaching modules and learning activities that meet industry requirements. (Tisch et al., 2016). Furthermore, the government has made higher education innovations to establish a technology-based industry that serves as a learning tool and produces various higher education innovations. (Ministry of Research and Higher Education, 2017).

Project-Based Learning (PBL)

The Project-Based Learning (PBL) learning model is a learning model that was developed in many developed countries, including the United States. Project-based learning translates to project-based learning in Indonesian. Project-based learning (PBL) is a method that employs projects or activities as a medium. Project-based learning is a learning method that uses problems to collect and integrate new knowledge gained from real-world experiences. (Ministry of Education and Culture, 2013).

Grant (2002) Defining project-based learning as a student-centered learning model for conducting an in-depth investigation of a topic. Students constructively deepen their learning by applying a

research-based approach to weighty, real-world problems and questions. The project itself is a hybrid of several different types of projects. According to Stoller (2006), there are three types of projects based on the nature and sequence of their activities: structured projects defined and arranged by the teacher in terms of topics, materials, methodologies, and presentations. Unstructured projects are defined primarily by students, and semi-structured projects are defined and managed by teachers and students.

Production projects include (1) newsletters, videos, radio programs, posters, written reports, essays, photos, letters, guidebooks, brochures, banquet menus, travel schedules, and so on; (2) performance projects include performances, oral presentations, theater performances, food exhibitions, or fashion shows; and (3) organizational projects include club formation, discussion groups, or conversation partner programs. Furthermore, Fried-Booth, D (2002) defines two types of projects: (1) small or simple projects requiring only two or three meetings. This project is only done in the classroom, and (2) full-scale projects necessitate complex activities outside the classroom to be completed over a longer period.

Made (2009) states that the Project-Based Learning model is a learning model that allows educators to manage classroom learning through project work. Project work is a type of work that consists of complex tasks based on difficult questions and problems. It guides students in designing, solving problems, making decisions, conducting investigations, and providing opportunities for students to work independently. Project-based learning has five characteristics, according to Thomas (2000): centrality, driving question, constructive investigation, autonomy, and realism. The project-based learning steps that were created by The George Lucas Educational Foundation (2007) can be seen in Figure 1 below.

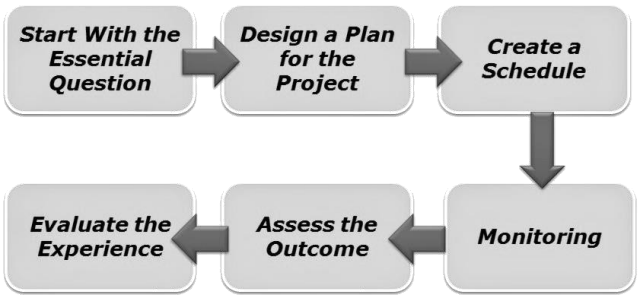

Figure 1. Project-Based Learning Steps (The George Lucas Educational Foundation, 2007)

Work-Based Learning (WBL)

Work-based learning (WBL) is a learning approach that uses the workplace to structure work-related experiences that contribute to learners' social, academic, and career development and supplement learning activities. WBL allows learners to develop attitudes, knowledge, skills, insights, behaviors, habits, and associations from their experiences in the two locations and learning related to real-life work activities. (Lynch, R.L. & Harnish, 1998). In comparison, Little (2006) states that WBL is all learning due to work activities.

According to (Johan & Harlan, 2014), WBL is a learning approach that focuses on the practical applications of learning and is thus directly applicable to students and their work environment. The WBL learning approach recognizes that learning can occur in various situations and settings and is not limited to classrooms or lecture halls. To support and enhance guided learning activities, all WBL programs employ a variety of tools. This blended learning approach enables WBL programs to be tailored to students' needs and preferences while remaining academically sound. WBL is a practical and effective method of creating university-level learning directly related to the workplace (Sutarto, 2017).

Teaching Factory (TeFa)

Teaching Factory (TeFa) has a long history in vocational education in various countries. In 1974, in

Germany, a construction company called Maschinenfabrik Augsburg Nürberg (MAN) Salzgitter collaborated with the Federal Institute for Vocational Training to make the company a place for skills training education to develop basic competencies, learning principles, and independent training. This program development aims to develop fundamental vocational skills in the construction industry. The TeFa learning concept was developed using the dual system learning method, which is widely used in vocational education in Germany and Switzerland. Tefa learning is defined as learning that integrates the environment in education and the environment in business and industry. In addition to students carrying out learning activities in the school/campus education environment, they also carry out practices to apply competencies in the business and industrial world within a certain period.

In Europe, factory-based learning is referred to as factory learning. A learning factory is a factory-based learning environment in which students learn directly how to make products using real technology and industry (Initiative on European Learning Factories, 2012). "learning factory" refers to an educational concept emphasizing experimental and problem-based learning. Enke et al. (2016) emphasize the philosophy of continuous, independent improvement through student interaction. Meanwhile, Kuswantoro (2014) defines a teaching factory as a real-world learning concept that bridges the competency gap between school knowledge and industrial needs. The teaching factory is a production unit development, namely the application of partner industry systems in SMK's existing production units.

The relationship of cooperation between vocational education and industry in the teaching factory learning pattern will positively impact the development of a systematic and planned partnership mechanism based on a win-win bargaining position. The teaching factory learning pattern bridges the gap between vocational education and the industrial world. At SMK, there is a check and balance of the educational process to maintain harmony (link and match) with the job market's needs. The teaching factory is a real-world learning concept that bridges the competency gap between industry needs and school knowledge. Innovative learning technologies and production practices are educational methods oriented toward student management in learning and aligned with industrial needs. (Stavropoulos et al., 2018). The Teaching Factory (TeFa) program is a hybrid of existing learning models, namely Competency-Based Training (CBT) and Production-Based Training (PBT), in that a process of expertise or skill (life skill) is designed and implemented based on actual work procedures and standards for producing products in response to market/consumer demands.

According to the State Board of Education (1997), production work in educational activities has several goals, including (1) preparing individuals to become workers, (2) preparing individuals to continue to higher education, (3) assisting students in choosing fields of work by their abilities; (4) demonstrating that "learning by doing" is very important for educational effectiveness; (5) defining the skills needed in the world of work; (6) expanding recruitment opportunities for students; and (7) providing opportunities for students. (8) provide opportunities for students to practice their skills so that they can make career decisions; (9) provide opportunities for teachers to build an "instructional bridge" between the classroom and the world of work; and (10) make the learning program more appealing and motivating students to learn.

In a broader sense, the teaching factory is not only limited to the physical environment but also the virtual environment, as shown by (1) the value-added production chain system (environment, process, and technology) can be displayed virtual, (2) interaction in teaching factory learning can be done by utilizing communication and information technology (in the network), and (3) the resulting product is a service. (Abele et al., 2015).

According to Alptekin et al. (2001), the following objectives are consistent with teaching factory learning and step or teaching factory learning syntax: (1) designing a product. In this session, students will develop or create a new product in the form of daily needs, design an image, make a program on a computer, etc., (2) designing a prototype, design a sample product or tester by product specifications,

(3) demonstrating and approving prototypes, students carry out demonstrate.

Green Campus Approach

The Republic of Indonesia Law No. 32 of 2009 regarding Environmental Protection and Management (PPLH), which contains regulations regarding the responsibilities and obligations of the central government, local governments, environmental stakeholders, and environmental management, as well as the community for a good environment and community obligations in the preservation and function of the environment, as well as controlling pollution and environmental damage. Meanwhile, the higher education environment created by KLH and the Ministry of Research, Technology, and Higher Education is recognized as a green campus / ecologically friendly campus initiative. Knirk & Frederick (1979) stated that higher education is a stimulating atmosphere for teaching and learning. A nice and comfortable campus environment may promote new research and discoveries, serve as a learning medium, as a forum for communication and debate, and as a location for study and meditation.

Management Universitas Sebelas Maret Green Campus gets support from the Ministry of Environment and Forestry, and the election of Universitas Sebelas Maret evidences this as one of the five Universities in Indonesia as the Pilot Project for the implementation of Green Campus in Indonesia. UNS already has a legal umbrella as the basis for the management policy of UNS Green Campus through UNS Rector Regulation Number 827A/UN27/KP/2013 concerning Guidelines for Environmental Friendly Campus Management, Sebelas Maret University. As a follow-up to this decision, UNS issued a Rector's Decree 13087/UN27/HK/2015 concerning the Establishment of the UI Green Metric World University Ranking Implementation Team Universitas Sebelas Maret as a form of green campus implementation, wherein 2019 UNS was able to rank seven universities in Indonesia and 96 in the world UI Green Metric World University Ranking (UNS, 2020b). The implementation policy for UNS Green Campus is contained in the rector's regulation, which includes six programs: (1) Governance and infrastructure, (2) Energy and Climate Change, (3) Waste Management, (4) Water Conservation, (5) Transportation, and (6) Education. Concerning the implementation of the teaching factory, the implementation scheme of the Green Campus program can be seen in Figure 2, where the program becomes an estuary for every element of vocational education implementation.

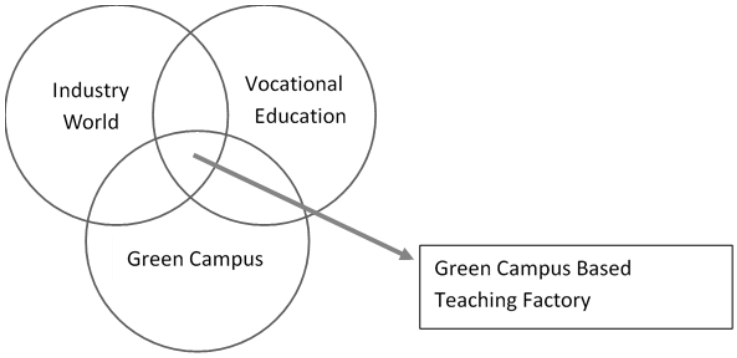

Figure 2. Green Campus-Based Teaching Factory Concept.

UNS is committed to preserving the environment within the campus environment, where efforts are made to create a healthy, comfortable, safe, beautiful, and energy-efficient campus through efficiency and effectiveness of energy use, mindset, and the behavior of all academics. One of the concrete actions that need to be realized in every learning subject taught on campus is behavior to create a clean campus, as in practical learning in workshops that produce a lot of waste that has not been appropriately managed. Waste management is one form of behavior that creates a green campus. The TeFa learning carried out in this workshop aims to produce the goods/services needed following the integration of the green campus program. The aim is to achieve products that align with market desires with an environmental perspective. In practice, learning steps based on environmental principles are expected to produce student behavior that reflects the quality of the environment.

Education is critical to human survival. Like the times, the education system changes dynamically in response to developments. (Johan & Harlan, 2014). A quality human resource system that can compete in the global era to produce educators who are skilled and competent in their fields and in line with the needs of the world of work is required for an education system.(Mavrikios et al., 2019; Mochammad Bruri Triyono, 2019). In this case, the emphasis in vocational technology education is more on developing skills, knowledge mastery, and attitude. A focus that a graduate of vocational-technical education must master to achieve predetermined educational goals is mastery of skills. (Andersen et al., 2019). The mastery of these skills is determined by age, education level, occupation, gender, and other environmental factors. (Hämäläinen et al, 2015). In this case, a graduate educator from an Indonesian tertiary institution would need four years of education to master the necessary skills.

The teaching factory is one of several learning models that can be used in vocational education. A learning process producing industry-standard products or services is called a teaching factory. Factory teaching is intended to improve students' ability in specific skills by industry standards, allowing them to compete in the workplace and independently as entrepreneurs (Stavropoulos et al., 2018; Vijayan et al., 2019). The teaching factory learning model can also help students improve their entrepreneurship competencies and skills. (Sumual & Soputan, 2018).

The teaching factory paradigm provides students and educators with a real-world environment to develop job skills and understand the challenges of daily industrial practice. (Louw & Deacon, 2020). The teaching factory (TeFa) program approach combines the Competency-Based Training (CBT) learning approach, in which the training provided is based on the work done by students at work. It emphasizes what a person can do as a result of training (output) rather than the quantity of training. (Leal et al., 2020; Ralph et al., 2020). In this case, the challenge of developing a teaching factory lies in an educational institution's management and organizational structure.

Using a teaching factory in collaboration between universities and industry in implementing learning in higher education results in students having skills that correspond to the industry's existing competencies. (Chryssolouris et al., 2016). Furthermore, advances in science and technology in the industry can be directly applied to the learning process in higher education. By replacing traditional software teaching based on tutorials, simple case studies, and an integrated learning approach, a teaching factory can be developed with the technology that sparked the fourth industrial revolution. (Sackey et al., 2017). It is a strategy that involves the relationship between elements in the learning system in educational institutions, and it always refers to the Indonesian national curriculum. (Suharno et al., 2020).

4. CONCLUSION

The results showed several things, such as that vocational education produces prospective educators at the undergraduate level who can develop skills in their fields of expertise. The skills obtained in learning are by the industrial world and the world of work as a solution to prepare students to enter the industry. The teaching factory learning model is suitable for bridging industry competencies into learning. So that teaching factory learning developed in universities can be integrated into implementing practice.

The results also show the synergy between teaching factory learning and green campus activity programs encouraging continuous improvement towards environmental improvement. This green campus-based teaching factory learning model combines work, education, and the environment. The world of work provides products that can be accepted in society, while education is a place for product development based on environmental insight. Model as a solution for practical learning in environmentally oriented vocational education.

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