Development of teaching factory competency-based for vocational secondary education in Central Java, Indonesia

by Bunyamin Bunyamin

Development of teaching factory competency-based for vocational secondary education in Central Java, Indonesia

Sintha Wahjusaputri, Bunyamin Bunyamin
Department of Education, Post Graduate Faculty, University of Muhammadiyah Prof. Dr. HAMKA, Jakarta, Indonesia

Article Info

Article history:

Received Jun 11, 2021
Revised Dec 29, 2021
Accepted Feb 1, 2022

Keywords:

Competence
Industry 4.0
Learning factory
Teaching factory
Vocational educational

ABSTRACT

This research was conducted to analyze the teaching factory model in vocational high school (*sekolah menengah kejuruan*/SMK) in Central Java Province, Indonesia according to the teaching factory's success factors. This research used meta-ethnography for qualitative methods and Delphi technique, Research and Development, and social problem-solving models for quantitative methods. This research involved five vocational secondary education in Central Java Province, Indonesia with 140 students as the respondents. The findings of teaching factory model implementation are applied to school management, human resources, marketing promotion, workshops, laboratories, learning patterns, and business and industry relationships. This model should increase the competency of graduates relevant to business and industry needs in the 4.0 era industry.

Corresponding Author:

Sintha Wahjusaputri
Department of Education, Post Graduate Faculty, University of Muhammadiyah Prof. DR. HAMKA
Daerah Khusus Ibukota Jakarta 12130, Indonesia
Email: sinthaw@uhamka.ac.id

1. INTRODUCTION

Facing global challenges due to the industrial revolution 4.0 in the 21st century, the President of Indonesia, issued presidential instruction Number 9 of 2016 regarding the vocational high school (SMK) revitalization. The big waves of the industrial revolution 4.0 breed unbelievably powerful disruptive technology and create new life turbulence and increasingly more challenging global competition. The Presidential Instruction aims to bring about significant vocational high school changes in Indonesia to become better and more competent vocational high schools. To achieve that purpose, Indonesia should prepare infrastructure that has been built in the last four years and improving the quality of people so that Indonesia does not get caught in the middle-income trap [1].

Positive achievements start to show in the third year of implementing the vocational high school's revitalization, following presidential instruction's mandate Number 9 of 2016 concerning Vocational Revitalization. According to the Head of Vocational High School Division at Kemendikbud (Ministry of Education and Culture), with the increase in vocational high school graduates' work participation rate, Kemendikbud has made adjustments to the curriculum and industrial cooperation in vocational education. So that align vocational education with the competencies needed for vocational high school graduates. Currently, the curriculum has been adjusted to be demand-driven so that the business world and the industrial world (*Dunia Usaha dan Dunia Industri*/DU-DI) are increasingly involved in the vocational education process at vocational high school. Therefore, vocational high school runs according to the business world's demands and Industry, namely by compiling a curriculum in collaboration with business and industrial partners (DU-DI), where DU-DI gets a share of 70% to determine the curriculum.

The learning theory contributes to the subjects being worked on, in which the students' problems in the industry. The learning theory is exemplified from each of the vocational training courses occupied by students theoretically and practically. Furthermore, success factors of the vocational high school in Central Java are: 70% for teaching factory management applied in schools, 85% for laboratories, 80% for teaching factory learning patterns, 70% for marketing /promotion, 78% for service products, 90% of human resources, and 75% for industry relations have reached [2]. Consequently, the problems which appeared from the students and infrastructure become a students' competencies development [3].

The teaching factory is a concept-based vocational learning on services and productions referring to the industry's standards and procedures. This program is implemented in an industrial-like atmosphere. Implementing the teaching factory at vocational high school can solved the competency gap between industrial needs and student's competency [4]. Teaching factory is a learning strategy that has several objectives. The teaching factory's objectives which are to produce professional graduates their fields, develop modern concepts curriculum, demonstrate the suitable solutions to facing the industrial world, and provide technology from industries that collaborate with students and educational institutions. Besides aiming to improve vocational high school graduates' competence, products or services from the teaching factory activities must be accepted by public. The products and services must meet the criteria for sale to generate added value for schools [5].

The teaching factory integrates the learning process to produce products and services worth selling to generate added value for schools. This means that the teaching factory process can instill an entrepreneurial spirit in students. In addition, the teaching factory process produces goods and services that have added value with quality that the community can absorb and accept. The production of goods and services include: i) what product is needed in the market; ii) why the product is purchased; iii) who is the buyer; iv) what is the buying process; v) what is the quality and appearance of the product; vi) how is the model; vii) what is the brand, how is the service and warranty. Implementing the teaching factory model integrates study and work and no longer separates between theoretical material. The success implementation of the teaching factory learning method can be seen from two leading indicators: utility and sustainable use of equipment. It can be seen through the implementation of block and continuous learning systems, also Integration of production processes or services into teaching materials [6].

It is not easy to apply the teaching factory concept. Apart from requiring a much budget, many aspects must be harmonized with the industrial world [7]. The first aspect that must be adjusted is the student learning curriculum in schools. This is needed so that everything students learn is in line with industrial conditions and needs [8]. The next step is to provide training for teachers through guidance from industry people who are experts in their fields. Next is to prepare school infrastructure to support the learning process with the teaching factory concept. Primarily, practicum rooms where students learn and practice their hard skills [9].

A learning factory is a system formed between a combination of "learning" and "factory, so that along the way, there is learning in a production environment. The student's ability to develop production competence is an essential requirement for industry-based learning [10]. Industry practitioners provide learning materials and industry-standard laboratories introduced to students in product design and manufacturing and provide guidance and motivation to manufacture products [11]. In industrial learning, to improve school productivity and efficiency, the latest advances in information and communication technology (ICT) must be included [12]. To complete the design of industrial learning, the level of education and technological infrastructure must be integrated. Firstly, the relevant subject matter must be determined according to future production needs. Students' competencies are the goal of industrial learning that must be determined. The students are equipped with literature and methods for creating certain products. Additionally, they were given a short lecture by a teacher, outlining and modeling the provided-literature concepts. After the lecturing is completed, the students are trained in the workshop/laboratory through discussion groups [13].

According to Stojkić and Bošnjak, to complete the industrial learning design, the education and technological infrastructure level must be aligned [14]. The industrial learning curriculum (learning-factory-curriculum-guide) must create a competency-oriented learning system. Relevant subject matter must be determined by the needs of the industry integrated with the school curriculum. Industrial learning uses the learning process as a training approach in an industrial environment by adopting renewable industry knowledge and technology to create innovations in improving critical thinking skills in solving a production problem [15]. An innovative learning environment positively impacts students because the students' ability to develop production potential is the main requirement for industrial-based learning [16]. The advantage of using this model in learning in vocational education is that students' practical abilities (skills) will be guaranteed to reach a professional level. According to one of the vocational education principle from Prosser, vocational education will be effective if under the original workplace [17].

2. RESEARCH METHOD

This research conducted using research and development model (R&D model) to encourage the teaching factory learning model as an industry-based learning system. The research and development model is a model to improve the quality of teaching factory learning in vocational secondary education. Furthermore, Research and Development model aims to find, develop and validate a product. Finding is the beginning of conducting research that aims to find knowledge about the basis of a thing while developing aims to develop knowledge that has been obtained from initial research in the form of a particular product. Hence, validating is conducted as an effort to test the effectiveness of the developed products. The teaching factory concept is constructed to improve students' productive subjects' competencies [12].

The teaching factory model applies six steps like a learning model using the R&D method. The six steps of one cycle of this model are: i) Receive the order; ii) Analyze the orders; iii) Show the readiness to work on orders; iv) Finish the orders; v) Conducting quality control; vi) Submit the orders [18]. The preliminary stage includes potential and problem analysis. This preliminary activity aims to find out the problems students face in the teaching factory learning process and find out the potential of products developed to help students overcome the problems they face related to the problem of learning independence. The product design stage is carried out through the design of the teaching factory learning model that has been prepared between the school and the DU-DI. Each step of the modeling describes the components of the product design developed between the two parties.

The development procedure indirectly provides instructions regarding procedural steps in producing product specifications that meet specific criteria according to the objectives of the industrial partners [7]. After the product is finished in the manufacturing process, validation is carried out to determine the feasibility of the teaching factory model. At this stage, the content validation of the model is carried out. With the implementation of content validation, the developed teaching factory learning model has revealed an assessment of the content of a concept to be conveyed. Content validation on the feasibility of the teaching factory learning model was carried out by consulting and asking for opinions and suggestions on products developed to experts from the business world and Industry as school partners. Validation to experts in this study stated whether the teaching factory learning model developed was ready to test students [19].

The stage of testing the product developed is the stage of implementing formative evaluation. This stage aims to find out the success of the learning model product developed in independent learning. This study uses the Delphi technique, which a qualitative approach used to predict an event's tendency in the future in which the decision-making process involved several experts. This method aims to combine expert opinions on a problem or event. The Delphi technique was engaged to measure the successful implementation of character education [20]. The distribution of respondent is presented in Table 1.

Table 1. Distribution of respondents

No	School	n
1	SMKN 4 Surakarta	24
2	SMKN 1 Temanggung	22
3	SMKN 7 Semarang	142
4	SMKS Muhammadiyah 1 Sukoharjo	10
5	SMKN PGRI 1 Kudus	17
	Total	215

The research using Slovin formula to determine the number of samples. Slovin formula is a mathematical system used to calculate the number of particular objects whose exact characteristics are unknown [21]. Slovin technique formula with 5% tolerable error is as (1):

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Where:
n=sample size
N=population size
e=error level (α=5%)

The sample calculation is as (2):

$$n = \frac{215}{1+125(0.05)^2} = 140 \; students \quad (2)$$

This study used four techniques for data collection, which are: i) Focus group discussion (FGD); ii) observation; iii) interview; and iv) documentation. The FGD activity involved 18 experts that consist of six principals, six coordinating teachers in the teaching factory [21], and six productive teachers in the teaching factory of five vocational high school in Central Java. The data were obtained through FGD. After carrying out FGD, the next step was to validate the model. The data analyzed quantitatively along with descriptive analysis techniques. One of the functions of descriptive analysis is to present research data in a simple form to portray an overview of research results. The qualitative data analysis technique was conducted to understand the results of validation data (assessments) from experts who had provided valuable information for the advancement and comprehensiveness of the teaching factory.

3. RESULTS AND DISCUSSION

This research uses the meta-ethnography approach to discover success factors in implementing the teaching factory model. As previously explained, data at the R&D method stage is a list of success factors validated to determine each teaching factory model [15]. The meta-ethnography method was introduced and described as an attempt to develop an inductive interpretive model of knowledge synthesis [17]. Meta-ethnography is a qualitative synthesis method but is different from the literature review. The literature review concludes to provide information about current knowledge. The qualitative synthesis method describes and integrates across studies to produce new understandings and views [16]. Meta-ethnography is an inductive interpretive approach that carries out reinterpretation of various research results or primary studies to produce or develop new theories to complement existing theories [17]. The synthesized studies are treated in the same way as the primary data. Meta-ethnography takes concepts that are often implicit in being linked together and compiled into a theoretical model with new meaning [18].

Meta-ethnography consists of seven steps as: i) Get started, where meta-ethnography researchers determine or identify research topics for the synthesis process. The research topic here is what is the main interest of the study being conducted; ii) Decide what is relevant to the initial interest, where the meta-ethnography researcher determines what is relevant to the research interest, including what studies will be involved. A searching strategy is needed at this stage, where the search process uses various types of electronic scientific databases. Searching can be done by using a various keyword that relevant with the initial interest; iii) Read the studies, where meta-ethnography researchers read repeatedly and review and mark concepts in the form of interpretive metaphors. The concept becomes raw data or input for the next synthesis process; iv) Determine how the studies are related. In doing the synthesis, various studies must be put together to require determining the relationship or relationship between the studies to be synthesized further. This stage involves making a list of critical metaphors, phrases, ideas or concepts and their relationships that are used in each account and combined. At the end of this phase, initial assumptions about the relationship between studies can be made. These assumptions can be in reciprocal translations, refutational translations, or argument sequences.

The indicators of teaching factory implementation successes at vocational high school in Central Java based on quality of the teaching factory framework consists of 30 items from 20 references ([22]–[41]) presented in Table 2.

i) The questionnaire was filled out by 215 students and the results of the questionnaire were calculated content validity coefficients for each success factor item using the Aiken's V formula. Based on the content validity significance standard (V), for 140 students (rater) and five categories (Likert scale), the minimum value of significant content validity (V) is rcount>rtable.
ii) The homogeneity-reliability coefficient was calculated for each item of the success factor using the given Aiken's H formula [2]. Based on the significant standard of homogeneity reliability (H), for 140 students in class XI-XII (rater) and five categories (Likert scale), the minimum coefficient of homogeneity (H) reliability value that was considered significant was 0.51 (H>0.51). Thus, if alpha>0.08 suggested all items were reliable, and all tests consistently had strong reliability. Therefore, the factory-teaching model's item factor success after the reliability testing using SPSS 24 there were 30 items declared reliable.
iii) Model social problem-solving model trains students to think systematically about all the problems they face and encourages them to design inventions [42]. Besides, it urges students to think and act creatively and solve problems realistically. It also inspires students to identify and investigate, interpret and evaluate observation in material learning, and stimulate progress in thinking. Students are also stimulated to solve problems faced appropriately. Thus, social problem-solving models make school education more relevant to life, find various ways out of difficulties encountered, analyze a problem from various aspects, and educate students confident about their abilities. The teaching factory learning implementation was measured using the social problem-solving model based on the indicators presented in Table 3.

According to the teaching factory model guide's assessment standards, the mean score was at intervals greater than 3.4-4.00, including excellent or proper categories. Therefore, the teaching factory model appropriately used with some improvements. Tvenge, Martinsen, and Kolla argued that the teaching factory model is validated in objectivity, practicality, and efficiency [43].

Table 2. V coefficient and H coefficient of teaching factory success factor

No	Teaching factory success factor	V coefficient	H coefficient	Sig.
1	I have work experience from DU-DI which supports teaching factory learning	0.757	0.917	0.000
2	I have received training/workshops/seminars from DU-DI that support competency achievement	0.669	0.916	0.000
3	I actively participate in training held by DU-DI	0.653	0.915	0.000
4	I can develop entrepreneurial potential/entrepreneurship through learning teaching factory	0.676	0.918	0.000
5	I understand the theory of managing teaching factory learning	0.658	0.917	0.000
6	I understand the teaching factory learning principles	0.712	0.918	0.000
7	It is easier for me to understand the material when it is practiced directly at the TEFA workshop service unit based on the procedures and standards of working in real DU-DI	0.559	0.920	0.000
8	I create an industrial working atmosphere in learning	0.762	0.919	0.000
9	I apply existing technology in the industry in learning	0.774	0.918	0.000
10	I apply industrial work culture in learning	0.751	0.918	0.000
11	I have a high work ethic	0.656	0.917	0.000
12	I have a high sense of responsibility in completing the work given by the teacher and the DU-DI	0.646	0.918	0.000
13	I have high self-confidence	0.687	0.919	0.000
14	I understand, obey and teach social norms	0.608	0.920	0.000
15	I maintain good communication with DU-DI	0.684	0.918	0.000
16	I have broad and in-depth knowledge about the subject matter given according to DU-DI standards	0.753	0.916	0.000
17	I have practical skills according to the subjects that I study	0.728	0.919	0.000
18	I get guidance and mentoring teachers in accordance with the competencies taught	0.699	0.918	0.000
19	I am passionate about exploring to create and develop products	0.660	0.918	0.000
20	Teaching factory as a solution in overcoming problems that arise during the learning process	0.722	0.916	0.000
21	DU-DI makes a contribution that adapts to the teaching factory learning design from the school	0.728	0.917	0.000
22	DU-DI provides training for instructors	0.715	0.917	0.000
23	DU-DI provides training for students	0.756	0.917	0.000
24	DU-DI provides training for school administrators.	0.723	0.921	0.000
25	DU-DI helps provide HR/instructor facilities	0.742	0.919	0.000
26	DU-DI helps provide infrastructure facilities	0.740	0.920	0.000
27	DU-DI helps provide learning resource facilities	0.649	0.919	0.000
28	Schools are actively offering cooperation with DU-DI	0.532	0.920	0.000
29	DU-DI involved in cooperation is more than 1	0.707	0.919	0.000
30	The production process is carried out in schools	0.696	0.919	0.000
31	The role of quality control is held by DU-DI	0.728	0.919	0.000

Table 3. The guiding of the teaching factory model assessment results

No	Indicators	Average
1	Clarity of the teaching factory model criteria and their implementation in vocational high schools	3.85
2	Clarity of the formulation of the objectives of the teaching factory model (production-based learning)	3.87
3	Scope of teaching factory model materials (production-based learning)	3.75
4	Clarity in designing teaching factory models (production-based learning)	3.88
5	Clarity of the teaching factory model (production-based learning)	3.90
6	Clarity of the role of schools and industries	3.95
7	Clarity of instruments' assessment	3.77
8	Clarity of evaluation criteria	3.85
9	Clarity in teaching factory outcomes (production-based learning)	3.95
10	Easy to understand statement	3.75
11	The clarity of words and sentences	3.80
	Average	3.85

Table 4 shows the implementation of teaching factory using social problem-solving methods is very high at each point (X=3.75 and above). Experts' responses showed that the average score was 5 for the suitability of each aspect of the assessment. Experts' judgments analysis on the second questionnaire concluded that the experts exposed a positive level of judgment in supporting the teaching factory model as social problem-solving. After going through the Delphi technique's three steps, the teaching factory model's implementation was proper for the students to face industry 4.0. Using direct results from three stages systematically using the Delphi technique, the researcher selected experts who are enthusiasts and ready to participate in this research activity and have enough time to answer the questionnaire.

The success factors for implementing the teaching factory model based on the results of interviews with vocational high school stakeholders in the Central Java Region include: i) School management, namely: financial administration, organizational structure, and job descriptions, SOPs for performance and workflow, leadership, school environment; ii) Workshop/laboratory facilities and infrastructure; iii) Teaching factory learning patterns; iv) Teaching factory-marketing promotion; v) Products and services; vi) Teaching factory resources; vii) School partnership with DU-DI.

Table 4. Expert judgment results using the social problem-solving method

No	Indicator	Average
1	The objectivity of the application of the teaching factory model in SMK of Central Java Province	3.95
2	The objectivity of the teaching factory model guide in SMK Central Java Province	3.85
3	The objectivity of data collection instruments	3.90
4	The practicality of measuring instruments for teaching factory models in SMK Central Java Province	3.80
5	The Practicality of guiding the implementation of the teaching factory model in SMK Central Java Province	3.87
6	The economical in the use of time	3.90
7	The economical use of fees	3.95
8	The economical in the use of power	3.87

4. CONCLUSION

The teaching factory guide model of expert validation results showed a mean score of 3.75, which means the model guide is good or worth testing. The findings of the teaching factory implementation model were measured using social problem-solving models. Implementing the teaching factory model is applied to school management, human resources, marketing-promotion, workshops, laboratories, learning patterns, and business and industry relationships. It increased the average score of 3.87 in five vocational high schools in Central Java.

The concept of developing the teaching factory model in vocational high school must be based on competency and the "link and match" program, also involve the government as policymakers of vocational education regulations in Indonesia. Therefore, schools, industry, and government have different roles and tasks in the successful development of the concept. The roles and tasks that must be provided by the school are make an alignment of competency-based curriculum in the industrial sector, fulfillment of practicum infrastructure needs (workshop and lab), meeting the needs of productive teachers, implementation of *praktek kerja industri*/*prakerin* (internship) for students and internships for teachers, and certificate of competence for vocational students.

The roles and tasks that must be provided by the industry are: providing input on curriculum alignment in vocational high schools, facilitating internship for students and industrial apprenticeship for teachers under expertise programs, facilitate the provision of instructors from industry as internship and internship supervisors, facilitate the provision of infrastructure for internships (workshops, teaching factories, and laboratories), and issuing a certificate has followed the internship. The last is role of the government to support concept of teaching factory development are development of competency infrastructure for vocational high school, provision of minimum practicum facilities in vocational high school, provision and training of instructors from industries.

REFERENCES

[1] S. Wahjusaputri, S. Fitriani, and I. El Khuluqo, "The Implementation of Teaching Factory and Its Implication to Vocational High School Student's Competence in the Industrial Area of Jakarta Province, Indonesia," in *Proceeding Kolokium Doktor dan Seminar Hasil Penelitian UHAMKA*, Apr. 2017, vol. 1, no. 2, pp. 21–28.

[2] S. Wahjusaputri, S. Fitriani, and S. Syarif, "Canvas Model Business as an Innovation of Teaching Factory Learning in the Fashion Department of 27 Public Vocational High School, Jakarta," *Dinamika Pendidikan*, vol. 14, no. 2, pp. 142–154, Dec. 2019, doi: 10.15294/dp.v14i2.21167.

[3] D. Mavrikios, K. Georgoulias, and G. Chryssolouris, "The Teaching Factory Paradigm: Developments and Outlook," *Procedia Manufacturing*, vol. 23, pp. 1–6, 2018, doi: 10.1016/j.promfg.2018.04.029.

[4] L. Rentzos, M. Doukas, D. Mavrikios, D. Mourtzis, and G. Chryssolouris, "Integrating manufacturing education with industrial practice using teaching factory paradigm: A construction equipment application," *Procedia CIRP*, vol. 17, pp. 189–194, 2014, doi: 10.1016/j.procir.2014.01.126.

[5] D. Mavrikios, K. Sipsas, K. Smparounis, L. Rentzos, and G. Chryssolouris, "A Web-based Application for Classifying Teaching and Learning Factories," *Procedia Manufacturing*, vol. 9, pp. 222–228, 2017, doi: 10.1016/j.promfg.2017.04.002.

[6] J. Wermann, A. W. Colombo, A. Pechmann, and M. Zarte, "Using an interdisciplinary demonstration platform for teaching Industry 4.0," *Procedia Manufacturing*, vol. 31, pp. 302–308, 2019, doi: 10.1016/j.promfg.2019.03.048.

[7] S. Lang, T. Reggelin, M. Jobran, and W. Hofmann, "Towards a modular, decentralized and digital industry 4.0 learning factory," in *Proceedings - 2018 6th International Conference on Enterprise Systems, ES 2018*, Oct. 2018, pp. 123–128, doi: 10.1109/ES.2018.00026.
[8] M. Tisch, E. Abele, and J. Metternich, "Overview on Potentials and Limitations of Existing Learning Factory Concept Variations," in *Learning Factories*, Cham: Springer International Publishing, 2019, pp. 289–321.
[9] H. Oberc, S. Fahle, C. Prinz, and B. Kuhlenkötter, "A practical training approach in learning factories to make artificial intelligence tangible," *Procedia CIRP*, vol. 93, pp. 467–472, 2020, doi: 10.1016/j.procir.2020.04.074.
[10] A. Kühn, R. Joppen, F. Reinhart, D. Röltgen, S. Von Enzberg, and R. Dumitrescu, "Analytics Canvas - A Framework for the Design and Specification of Data Analytics Projects," *Procedia CIRP*, vol. 70, pp. 162–167, 2018, doi: 10.1016/j.procir.2018.02.031.
[11] D. Mourtzis, V. Zogopoulos, and E. Vlachou, "Augmented Reality supported Product Design towards Industry 4.0: A Teaching Factory paradigm," *Procedia Manufacturing*, vol. 23, pp. 207–212, 2018, doi: 10.1016/j.promfg.2018.04.018.
[12] F. Baena, A. Guarin, J. Mora, J. Sauza, and S. Retat, "Learning Factory: The Path to Industry 4.0," *Procedia Manufacturing*, vol. 9, pp. 73–80, 2017, doi: 10.1016/j.promfg.2017.04.022.
[13] T. D. Brunoe, S. T. Mortensen, A. L. Andersen, and K. Nielsen, "Learning factory with product configurator for teaching product family modelling and systems integration," *Procedia Manufacturing*, vol. 28, pp. 70–75, 2019, doi: 10.1016/j.promfg.2018.12.012.
[14] Ž. Stojkić and I. Bošnjak, "Development of Learning Factory at FSRE, University of Mostar," *Procedia Manufacturing*, vol. 31, pp. 180–186, 2019, doi: 10.1016/j.promfg.2019.03.029.
[15] M. Hennig, G. Reisinger, T. Trautner, P. Hold, D. Gerhard, and A. Mazak, "TU Wien Pilot Factory Industry 4.0," *Procedia Manufacturing*, vol. 31, pp. 200–205, 2019, doi: 10.1016/j.promfg.2019.03.032.
[16] R. Glass, P. Miersch, and J. Metternich, "Influence of learning factories on students' success - A case study," *Procedia CIRP*, vol. 78, pp. 155–160, 2018, doi: 10.1016/j.procir.2018.08.307.
[17] A. Prianto, Winardi, and U. N. Qomariyah, "The Effect of the Implementation of Teaching Factory and Its Learning Involvement toward Work Readiness of Vocational School Graduates," *International Journal of Instruction*, vol. 14, no. 1, pp. 283–302, Jan. 2020, doi: 10.29333/IJI.2021.14117A.
[18] S. Herliana, "Regional Innovation Cluster for Small and Medium Enterprises (SME): A Triple Helix Concept," *Procedia - Social and Behavioral Sciences*, vol. 169, pp. 151–160, Jan. 2015, doi: 10.1016/j.sbspro.2015.01.297.
[19] H. Barton and R. Delbridge, "HRM in support of the learning factory: Evidence from the US and UK automotive components industries," *International Journal of Human Resource Management*, vol. 15, no. 2, pp. 331–345, Mar. 2004, doi: 10.1080/0958519032000158545.
[20] L. Silanoi, "The Development of Teaching Pattern for Promoting the Building up of Character Education Based on Sufficiency Economy Philosophy in Thailand," *Procedia - Social and Behavioral Sciences*, vol. 69, pp. 1812–1816, Dec. 2012, doi: 10.1016/j.sbspro.2012.12.131.
[21] Sugiyono, *Statistics for Research*. Bandung: Alfabeta (in Indonesian), 2014.
[22] P. Steininger, "Learning Factory-Integrative E-Learning," in *International Conference e-Learning*, 2017, pp. 164–168.
[23] D. E. Hardt, B. W. Anthony, and S. B. Tor, "A teaching factory for polymer microfabrication – μFac," *International Journal of Nanomanufacturing*, vol. 6, no. 1–4, p. 137, 2010, doi: 10.1504/IJNM.2010.034779.
[24] A. M. Khoiron, "the Influence of Teaching Factory Learning Model Implementation To the Students' Occupational Readiness," *Jurnal Pendidikan Teknologi dan Kejuruan*, vol. 23, no. 2, p. 122, Oct. 2016, doi: 10.21831/jptk.v23i2.12294.
[25] G. Southern, "Teaching factory management a practical approach," *European Journal of Engineering Education*, vol. 7, no. 1, pp. 189–200, Jan. 1982, doi: 10.1080/03043798208903652.
[26] A. Haris, "Learning system management based on teaching factory in Indonesia," *Journal of Advanced Research in Social Sciences and Humanities*, vol. 2, no. 4, Aug. 2017, doi: 10.26500/jarssh-02-2017-0402.
[27] Wafroturrohmah, M. F. J. Syah, Suyatmini, F. Faathirisshofia, and N. Rofi'ah, "Evaluation on teaching factory implementation: Studies in management, workshop, and learning-pattern aspects," *International Journal of Innovation, Creativity and Change*, vol. 12, no. 2, pp. 203–215, 2020.
[28] D. Mourtzis, J. Angelopoulos, and N. Panopoulos, "Blockchain in Engineering Education: The Teaching Factory Paradigm," *SSRN Electronic Journal*, 2021, doi: 10.2139/ssrn.3859151.
[29] T. Kuat, "Implementation of Edupreneurship Through the Teaching Factory in Vocational High School of Hotel Accommodation: Case Study At Smk N 6 Yogyakarta," *Journal of Vocational Education Studies*, vol. 1, no. 1, p. 7, May 2018, doi: 10.12928/joves.v1i1.590.
[30] J. S. Lamancusa, J. E. Jorgensen, and J. L. Zayas-Castro, "Learning Factory - a new approach to integrating design and manufacturing into the engineering curriculum," *Journal of Engineering Education*, vol. 86, no. 2, pp. 103–112, Apr. 1997, doi: 10.1002/j.2168-9830.1997.tb00272.x.
[31] M. Tisch, C. Hertle, E. Abele, J. Metternich, and R. Tenberg, "Learning factory design: a competency-oriented approach integrating three design levels," *International Journal of Computer Integrated Manufacturing*, vol. 29, no. 12, pp. 1355–1375, Dec. 2016, doi: 10.1080/0951192X.2015.1033017.
[32] H. Hadlock, S. Wells, J. Hall, J. Clifford, N. Winowich, and J. Burns, "From Practice to Entrepreneurship: Rethinking the Learning Factory Approach," in *Proceedings of The 2008 IAJC IJME International Conference*, 2008, p. 231.
[33] M. Nardello, O. Madsen, and C. Møller, "The smart production laboratory: A learning factory for industry 4.0 concepts," *CEUR Workshop Proceedings*, vol. 1898, 2017.
[34] R. Rojas, E. Rauch, P. Dallasega, and D. T. Matt, "Safe human-machine centered design of an assembly station in a learning factory environment," in *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 2018, vol. 2018-March, pp. 403–411.
[35] J. S. Lamancusa, J. E. Jorgensen, J. L. Zayas-Castro, and L. M. de Morell de Ramirez, "The Learning Factory - Integrating design, manufacturing and business realities into engineering curricula - a sixth year report card," in *International Conference on Engineering Education*, 2001, pp. 1–6.
[36] A. Jaeger, W. Mayrhofer, P. Kuhlang, K. Matyas, and W. Sihn, "The 'learning factory': An immersive learning environment for comprehensive and lasting education in industrial engineering," *WMSCI 2012 - The 16th World Multi-Conference on Systemics, Cybernetics and Informatics, Proceedings*, vol. 2, pp. 237–242, 2012.
[37] P. Steininger, "Learning Factory – Assembling Content With Patterns, Models, Frameworks and Tools," in *INTED2017 Proceedings*, Mar. 2017, vol. 1, pp. 5573–5580, doi: 10.21125/inted.2017.1301.
[38] A. M. M. S. Ullah, "Fundamental issues of concept mapping relevant to discipline-based education: A perspective of manufacturing engineering," *Education Sciences*, vol. 9, no. 3, p. 228, Aug. 2019, doi: 10.3390/educsci9030228.

[39] H. Barton and R. Delbridge, “Delivering the ‘learning factory’?: Evidence on HR roles in contemporary manufacturing,” *Journal of European Industrial Training*, vol. 30, no. 5, pp. 385–395, Jun. 2006, doi: 10.1108/03090590610677935.
[40] D. Pittich, R. Tenberg, and K. Lensing, “Learning factories for complex competence acquisition,” *European Journal of Engineering Education*, vol. 45, no. 2, pp. 196–213, Mar. 2020, doi: 10.1080/03043797.2019.1567691.
[41] H. Barton and R. Delbridge, “Development in the learning factory: Training human capital,” *Journal of European Industrial Training*, vol. 25, no. 9, pp. 465–472, Dec. 2001, doi: 10.1108/03090590110410313.
[42] E. Dolan, E. Hancock, and A. Wareing, “An evaluation of online learning to teach practical competencies in undergraduate health science students,” *Internet and Higher Education*, vol. 24, pp. 21–25, Jan. 2015, doi: 10.1016/j.iheduc.2014.09.003.
[43] N. Tvenge, K. Martinsen, and S. S. V. K. Kolla, “Combining Learning Factories and ICT- based Situated Learning,” *Procedia CIRP*, vol. 54, pp. 101–106, 2016, doi: 10.1016/j.procir.2016.03.031.

BIOGRAPHIES OF AUTHORS

Sintha Wahjusaputri is currently a Permanent Lecturer in Education Statistics, Education Management, Research Methodology, Faculty of Post Graduate School, Education Administration Study Program of Muhammadiyah University Prof. Dr. HAMKA Jakarta, Indonesia. She received her doctoral degree in University of Jakarta (UNJ), Indonesia. Her scientific article work has been widely published in various journals in the field of Vocational Education. In addition, she also actively writes books on the Development of Vocational Secondary Education in Indonesia. She can be contacted at email: sinthaw@uhamka.ac.id.

Bunyamin is a Lecturer in Education Management and TQM in Education at the Graduate School and at the Faculty of Islamic Religion, University of Muhammadiyah Prof. Dr. HAMKA. In addition to being active in teaching and researching, he also serves as Vice Chancellor IV of UHAMKA in 2019-2023. He completed his doctoral studies in education management at the State University of Jakarta (UNJ) in 2013. Completed his master's studies at the Islamic University of Jakarta in the field of Islamic education management in 2005. And obtained his bachelor's degree from the University of Muhammadiyah Surakarta (UMS) in 1991. He is also active in writing, among his works are the Implementation of the Prophet Muhammad's Learning Strategies and Religious Culture-Based Management. The author can be contacted via email: bunyamin@uhamka.ac.id.

Development of teaching factory competency-based for vocational secondary education in Central Java, Indonesia

ORIGINALITY REPORT

15%	12%	8%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	ijicc.net Internet Source	5%
2	edulearn.intelektual.org Internet Source	2%
3	E Diwangkoro, Soenarto. "Development of teaching factory learning models in vocational schools", Journal of Physics: Conference Series, 2020 Publication	1%
4	Rinaldo Adi Pratama, Inne Marthyane Pratiwi, Muhammad Adi Saputra, Sumargono Sumargono. "Integration of STEM education in history learning", International Journal of Evaluation and Research in Education (IJERE), 2022 Publication	1%
5	Riski Gustiar, Kurniawati Kurniawati, Murni Winarsih. "The Challenges of Teaching Indonesian History in The Teaching Factory	1%

Learning Model in Vocational High School", AL-ISHLAH: Jurnal Pendidikan, 2021
Publication

6	jurnal.ustjogja.ac.id Internet Source	1 %
7	www.atlantis-press.com Internet Source	1 %
8	Submitted to Academic Library Consortium Student Paper	1 %
9	Submitted to University of Sunderland Student Paper	1 %
10	cyberleninka.org Internet Source	1 %
11	Željko Stojkić, Igor Bošnjak. "Development of Learning Factory at FSRE, University of Mostar", Procedia Manufacturing, 2019 Publication	<1 %
12	Agustina Sri Purnami, Mulyanto Mulyanto, Susilo Utomo. "Teaching factory, internal quality assurance system, and vocational teacher quality culture", Journal of Education and Learning (EduLearn), 2021 Publication	<1 %
13	Nurulwahida Azid, Ruzlan Md. Ali, Ihsana El Khuluqo, Sigid Edy Purwanto, Eka Nana Susanti. "Higher order thinking skills, school-	<1 %

based assessment and students' mathematics achievement: Understanding teachers' thoughts", International Journal of Evaluation and Research in Education (IJERE), 2022

Publication

14	R C Putra, I H Kusumah, M Komaro, Y Rahayu, E P Asfiyanur. "Design Learning of Teaching Factory in Mechanical Engineering", IOP Conference Series: Materials Science and Engineering, 2018 Publication	<1 %

Exclude quotes	On	Exclude matches	< 17 words
Exclude bibliography	On		