Problem solving improvement through the teaching factory model

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Abstract. The dominance of Indonesia's youth unemployment rate is currently occupied by vocational school graduates. The incompatibility of competencies prepared in vocational schools with the competencies needed by the labour market triggers this unemployment rate. Discussion of employability skills as a basic skill is high among human resource developers. The learning process must pay attention to the profile of labour needed so that the gap can be overcome. This study aims to measure the increase in employability skills in problem solving skills of students through teaching factory model. The study sample was 60 students from vocational schools who conducted teaching factory on bread production in West Java. Improved problem solving skills are measured based on 5 indicators, are work safety, managing facilities, making decisions, knowing how to learn, and solving problems. 37 competency units are prepared based on national work standards as a guideline for measuring students' problem solving skills. Achievement of employability skills in problem solving skills of students in SMKN 1 Pacet is higher than SMKN 1 Cibadak, and SMKN 2 Subang. The causes of differences in the achievement of employability skills are discussed.

1. Introduction
The youth unemployment rate in Indonesia is still dominated by vocational school graduates. Data from the survey shows 11.24% of Indonesia's young unemployed are vocational school graduates, higher than general secondary school graduates, namely 7.95% [1]. This fact is not in line with vocational school duties as systemic integration that connects work and education, so it plays a role in preparing students to be able to compete in the labor market [2]. This high unemployment rate shows a problem in the process of transforming vocational schools with the labor market [3]. Several previous studies discussed several factors that caused the transition to be not optimal in the transformation process, namely differences in competence [4], impartial education policies [5], and students who had problems in determining school [6].

The process of identifying competency needs for each job needs to be done to find out the profile which is an individual prerequisite for entering the labor market [7]. Determination of the right learning model can increase learning productivity [8]. Work-market-oriented learning with competencies that have been adjusted based on labor market demand, must be optimized as debriefing and development of certain competencies as needed [9]. One labor market oriented learning model is a teaching factory.

The teaching factory model has a basic concept of "Factory to Classroom" which aims to adjust the production environment in industry with laboratories in vocational schools [10,11]. The creation of an industrial atmosphere, tools such as industry, and rules applied in industry are the main characteristics
of teaching factories. The application of block learning systems in classrooms and practice rooms provides opportunities for students to develop their skills. The teaching factory has a strategic value in vocational education and training in increasing the competitiveness of vocational school graduates in the labor market, because it has a mechanism to keep up with the rapid development of the industry so that the competence of graduates is highly considered [10]. The literature findings indicate an increase in employers' demand for workers who have the ability to work as basic skills in dealing with difficulties in the work environment [12]. The three employability skills needed by industry are communication, problem solving, and cooperation [13–17]. This study aims to measure the improvement of students' problem solving skills through teaching factory learning.

2. Research method
Concurrent triangulation was chosen as the design of this study. Qualitative data and quantitative data are combined to determine the improvement of students' skills in solving problems through learning bread production. Semi-structured interviews were chosen to study the implementation of teaching and learning in three vocational schools. Performance assessment is used to measure the increase in student employability skills. Purposive samples were chosen to determine the study sample from the study population. 60 students from expertise competencies processing of agricultural products from three vocational schools were chosen as research samples are SMK 1 Cibadak, SMKN 1 Pacet, and SMKN 2 Subang. Problem solving skills are presented in the five indicators shown in Table 1.

Table 1. Indicators of problem solving skills.

| Skill             | Indicator                |
|-------------------|--------------------------|
| Problem solving   | Work safety              |
|                   | Managing facilities      |
|                   | Decision-making          |
|                   | Know how to learn        |
|                   | Resolving the problem    |

Indicators of problem solving skills are explained in the rubric analysis as a measurement guide. The description of each indicator is presented in Table 2.

Table 2. Description of indicators of problem solving skills.

| Indicator          | Description                                                                 |
|--------------------|-----------------------------------------------------------------------------|
| Work safety        | Have awareness of procedures or personal or group safety and health practices, and are able to apply standard operating procedures correctly in working in the laboratory |
| Managing facilities| Store, organize, and distribute materials, components, equipment, and end products so that they can be used correctly          |
| Decision-making    | Setting goals, making choices, calculating risks, assessing, and determining the best choice in carrying out the practice |
| Know how to learn  | Use appropriate analytical techniques, apply the knowledge, and skills possessed in new unknown situations |
| Resolving the problem | Understanding problems, identifying possible reasons, completing and implementing action plans to address them; assess and monitor progress and improve work plans based on field data |

3. Results and discussion

3.1. Results of problem solving skills measurement
Measurement of problem solving skills consists of five main indicators, namely work safety, managing facilities, making decisions, knowing how to learn, and solving problems. Occupational safety indicators
include personal quality competencies in the basic skills group. Indicators for managing facilities include resource competencies in group workplace competencies. Making-decision, knowing how to learn, and resolving problems include competency skills in the basic skills group. The results of measuring problem solving skills in three vocational schools are presented in the figure below.

Linear graph of the results of measurement of problem solving skills of SMKN 1 Cibadak students’ increased in the good category. The measurement results increase for indicators that manage facilities, make decisions, know how to learn, and solve problems. Decrease in measurement results can be seen in work safety indicators. The results of the measurement of problem solving skills of SMKN 1 Cibadak students are presented in Figure 1.

![Graph of SMKN 1 Cibadak students’ problem solving skills](image1)

**Figure 1.** Graph of SMKN 1 Cibadak students’ problem solving skills.

Linear graph of the measurement results of problem solving skills of SMKN 1 Pacet students’ increased in the good category. There is an increase in the measurement results of work safety indicators, managing facilities, knowing how to learn, and solving problems. The decline is seen in the results of decision-making indicators. The results of measuring the problem solving skills of SMKN 1 Pacet students are presented in Figure 2.

![Graph of SMKN 1 Pacet students’ problem solving skills](image2)

**Figure 2.** Graph of SMKN 1 Pacet students’ problem solving skills.

Linear graph of the measurement results of problem solving skills of SMKN 2 Subang students increases in the good category. The measurement chart shows an increase in managing facilities indicator, decisions making indicator, know how to learn indicator, and resolving problems indicator. Decrease in measurement results can be seen in the second measurement result of work safety indicators, know how to learn indicators, and in the results of the third measurement on resolving the problem indicators. The
results of the measurement of problem solving skills of students of SMKN 2 Subang are presented in Figure 3.

![Graph of SMKN 2 Subang students’ problem solving skills](image)

**Figure 3.** Graph of SMKN 2 Subang students’ problem solving skills.

3.2. Students’ problem solving skills through teaching factory

Problem solving skills in this study are limited to five indicators, namely work safety, managing facilities, making decisions, knowing how to learn, and solving problems. These indicators are explained in the competency unit to facilitate the measurement of improvement in work skills by researchers.

3.2.1. Work safety. Work safety is an aspect of competence in personal quality. In all three vocational schools, work safety indicators are in the good and excellent category. This shows that the quality of personal competencies of each student in the three vocational schools is good so students are considered ready to enter the workforce. Based on the results of the studies, teaching factory that implemented real work has a positive impact on students' attitudes and work attitudes. Work safety is very important and must be prioritized. The occupational safety competency unit measured in this study was the use of personal protective equipment during practical learning, and sanitation of used equipment and personal hygiene.

3.2.2. Managing facilities. Indicators for managing facilities include resource competency groups. The measurement results of this indicator are in the good category and are very good at the final stage of measurement. However, there were different results for the three schools when the initial observations were made, which were in the good, not good, moderate, and very good categories. Indicators for managing facilities are measured by several competency units, namely skills to ensure the availability of equipment used, ensuring availability of raw materials needed, ensuring availability of supporting materials, and cleaning up production equipment used.

3.2.3. Decisions-making. Decisions-making includes thinking skills competency. In the world of work making decisions is very important especially in an emergency. Taking decisions is closely related to students' knowledge and experience during learning, so it is very important to note the increase. The competency unit assessed on the indicators of decision making includes the skill of selecting raw materials and supporting materials, determining the process end points at each stage of production, determining the time needed to carry out each stage of production, determining the temperature and humidity, determining the critical end points at each stage of production, handle production properly, handle production waste appropriately, determine appropriate packaging materials, carry out packing according to standards, determine selling prices, determine marketing strategies, and market products.

3.2.4. Know how to learn. Know how to learn indicator includes thinking skills competency. In the work environment, the speed of someone to adapt in a new environment is very necessary, therefore it is very
important to measure the competency of student indicators to find out how to learn. The competency unit that is measured to see an increase in indicators knows how to learn includes the skills to operate the balance sheet to weigh materials, operate the mixer appropriately, mix at the right speed, carry out initial fermentation appropriately, properly dispose of gas in bread, weigh cuts according to bread recipe produced, filling bread, operating the mold mixture, printing according to the production plan, carrying out final inspection, operating the oven to bake, lifting baked bread and packaging according to the standard. Based on the analysis of observations in three aspects of vocational schools knowing how to study is in the good and very good category, this shows that students have readiness to adapt to the work environment.

3.2.5. Resolving the problem. Resolving the problems indicator includes thinking skills competency. Based on the literature review, resolving problem is a skill that is very much needed in the work environment. Workers will experience various challenges both from inside and outside while doing work. Competency units measured in problem solving indicators include skills in ensuring the temperature of water used in the mixing process, identifying absorption of water in the mixing process, mixing until the dough becomes smooth, ensuring yeast activity on the dough, ensuring the oven temperature is used for baking, identifying the quality of bread according standards, and identify errors in bread that are not in accordance with the standard.

The final achievement in measuring problem solving skills in three vocational schools is presented in Figure 4. Based on the analysis of observations it was found that the problem solving skills of SMKN 1 Pacet were higher than those of SMKN 1 Cibadak, and SMKN 2 Subang. The learning process of teaching factory at Pacet 1 State Vocational School is implemented based on procedures and real job standards of habituation in applying work safety, personal hygiene standards, use of personal protective equipment, process of identifying raw material quality, production processes, product testing, marketing, and product distribution. Optimizing the role of peer tutors during the learning process takes place contributing to the course of the learning process. The role of peer tutors is not only to assist students in completing technical matters, but as a description of personal competencies students should have. Teaching factory at SMKN 1 Pacet integrates several subjects, are fermentation, oven heat use, application of good manufacturing practices, application of work safety, sanitation and product quality analysis. Differences in the implementation of teaching factory in these three schools affect the final results of measuring student problem solving skills.

![Problem solving skills achievement](image)

**Figure 4. Problem solving achievement.**

4. Conclusion

Implementation of teaching factory based on procedures, standards of real work, and direct experience influence the results of student problem solving skills. The implementation of teaching factory in three vocational schools varies according to the conditions and readiness of each school. Improved problem solving skills are measured based on five indicators, are work safety, managing facilities, making decisions, knowing how to learn, and resolving problems. There are at least thirty-seven competency units based on national work standards that can be a guideline for measuring student problem solving.
skills in bread production. The final achievement of problem solving skills of SMKN Pacet 1 students is higher than those of SMKN 1 Cibadak and SMKN 2 Subang students because the involvement of SMKN 1 Pacet students is higher than the other two vocational schools.

References
[1] BPS 2018 Keadaan Ketenagakerjaan Indonesia
[2] Kamasheva Y L et al. 2016 Features of Vocational Education Management in the Region Int. Rev. Manag. Mark. 6 (1) 155–159
[3] Osmani M et al. 2015 Identifying the Trends and Impact of Graduate Attributes on Employability: a Literature Review Tert. Educ. Manag. 21 (4) 367–379
[4] Moses K M and Wibawa A P 2016 The linkage between vocational schools and industries cooperation: A comparison in developed and developing countries Int. Conf. Educ. 2016 483–492
[5] Xing C, Yang P and Li Z 2018 The medium-run effect of China’s higher education expansion on the unemployment of college graduates China Econ. Rev. 51 181–193
[6] Oluwajodu F, Blauw D, Greyling L and Kleyhans E P J 2015 Graduate unemployment in South Africa : Perspectives from the banking sector SA J. Hum. Resour. Manag. 1 (13) 1–9
[7] Hecklau F, Galeitzke M, Flachs S and Kohl H 2016 Holistic Approach for Human Resource Management in Industry 4.0 Procedia CIRP 54 1–6
[8] Allen E R 2016 Analysis of Trends and Challenges in the Indonesian Labor Market Cornell Univ. ILR Sch. Int. Publ. 1 (16) 1–38
[9] Feldmann L and Sprafke N 2016 How to Design Empowering Work-based Learning Settings to Foster Students’ Competence Development Int. J. Cross-Disciplinary Subj. Educ. 6 (1) 2081–2089
[10] Kejuruan D P S M 2017 Evaluasi Tata Kelola Kelembagaan dan Pembelajaran SMK 3 Tahun (Direktorat Pembinaan Sekolah Menengah Kejuruan)
[11] Chryssolouris G, Mavrikios D and Rentzos L 2016 The Teaching Factory: A Manufacturing Education Paradigm Procedia CIRP 57 44–48
[12] Ritter B A, Small E E, Mortimer J W and Doll J L 2018 Designing Management Curriculum for Workplace Readiness: Developing Students’ Soft Skills J. Manag. Educ. 42 (1) 80–103
[13] Yusof M, Mustapha R, Malik S A, Mohamad S and Bunian S 2012 Measurement Model of Employability Skills Using Confirmatory Factor Analysis Procedia - Soc. Behav. Sci. 56 348–356
[14] Rasul M S, Rose R A and Mansor A N 2013 Employability skills indicator as perceived by manufacturing employers Asian Soc. Sci. 9 (8) 42–46
[15] Lapi J A and Ščeulovs D 2014 Employability and Skills Anticipation: Competences and Market Demands Procedia - Soc. Behav. Sci. 156 404–408
[16] Normala R, Yahya B and Abdul Rahman A 2015 Determination of Constructs and Dimensions of Employability Skills Based Work Performance Prediction : A Triangular Approach Int. J. Econ. Financ. Issues 5 183–189
[17] Suleman F 2016 Employability Skills of Higher Education Graduates: Little Consensus on a Much-discussed Subject Procedia - Soc. Behav. Sci. 228 169–174