A Case Study: Gap Competency Between Mechanical Engineering Graduates of Vocational High School and The Demand in Workplace

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Abstract. This study explores the workplace competencies, especially in the production machine operators, and finds the existing gap between the competency of mechanical engineering graduates of Vocational High School (Indonesian: Sekolah Menengah Kejuruan; abbreviated as VHS) and the demanded skills in the workplace. The research method employed in this research is the qualitative-explorative research method. In this research, it can be acknowledged that in a broader aspect, the competencies of the mechanical profession of motorcycles, cars, and operators of production machines can be clustered into three groups of skills: base, core, and supporting competencies. Based on the four competencies’ competency map, the vocational school graduates’ basic competencies are unfulfilled in the production workshop: (1) reading the technical drawing and (2) using the hand tools. Moreover, VHS graduates of the mechanical engineering department are still shortage of core competencies, hence still occupying at "lack of comprehension" level equal to more than 33%. On the other hand, the vocational school graduates' supporting competency is in a minor percentage, according to the workshop's head, chief engine operator, and senior operator in the workshop.

1. Introduction

Vocational High School (VHS) is a part of the education system preparing a person to work in the one specific workforce such as automotive, industry, agriculture, office, etc. According to the National Constitution Law no. 20, article 15, about the National Education System, vocational education is an education that prepares students to work in a particular field. The number of students entering vocational high school, in both public and private, depicted an increasing trend: 4,682,913 students in 2016, grew to 4,785,106 in 2017, while in 2019 increased to 5,034,496 (Statistic Data of VHS PDSP DAPODIK [1]). Therefore, the government's commitment to revitalizing VHSs proclaimed should be a momentum to establish vocational education in the vocational school to fulfill the need for skilled, high-quality labor at the middle level. However, data from The Central Bureau of Statistics as of February 2020 [2] showed that VHS graduates' open unemployment rate was very high at 8.49% of unemployed graduates in the workforce (Fig. 1). This condition puts VHS as the first contributor of open unemployment based on the education level, followed by Senior High School and diploma programs in the second and third places. This phenomenon is contrary, not in line with the function and purpose of vocational education in Indonesia where vocational graduates should be ready and employed in the work field.
Figure 1. Indonesia's open unemployment rate of February 2019-2020  
(Source: The Central Bureau of Statistic, May 5, 2020 [2])

Prosser and Ougley, 1950 [3] proposed the ideal concept for vocational education through Prosser's Sixteen Theorems on Vocational Education. One of Prosser's Sixteen Theorems, namely vocational education, will be efficient if the environment in which students are trained is a replica of the environment in which they will work later. This can be interpreted that the competencies in the VHS curriculum must be following the industry. The competence of VHS graduates is the key to acceptance in the job market. Several studies regarding competence in VHS Indonesia have been conducted, such as Saputro et al. 2018 [4], which examined the production-based education in VHS. Estriyanto et al., 2017 [5] who examined teacher competency in VHS, Indonesia. The suitability of competencies in the industry is a significant concern that must be done [6]. However, not all industries pay attention to the world of education, as reported in Wibowo and Munadi’s research, 2019 [7].

One of the main problems faced by VHSs in Surakarta is the absence of suitability between the expected competencies in the workplace and competencies prepared for graduates. For instance, the unacceptability of automotive graduates' mechanics in some authorized workshops in Surakarta due to lack of competency. Some students of VHSs are also refused to conduct industrial work practice in machinery workshop because of the inability to operate Computer Numerical Control (CNC) machine. According to the learning problem (lack of competency) in vocational education and the high unemployment rate of vocational graduates, it is strongly necessary to research "A Case Study: Gap Competency between Mechanical Engineering Graduates of Vocational High School and The Demand in Workplace."

2. Research Method

This research employs a qualitative method with an explorative survey design. The use of explorative survey design is intended to solve problem-solving by finding problems, estimating and formulating solutions, building new ideas or relationships through phenomena or events occurring in the community, based on the field's facts. In this research, the expected problems to solve are about the competencies that must be possessed and comprehended by the production machine operators. The research subjects were production machine operators in 4 large manufacturing companies (PT. King Manufacture, PT. Sinar Agung Always Success (SAS), PT. Success Plasindo, and CV. Rigen Sarana Mukti). The research object is focused on the competency map of the automotive mechanic profession and the mechanic’s competence as a production machine operator.

3. Result and Discussion

From the previous research in the machining workshops of PT. King Manufacture, PT. Sinar Agung Selalu Sukses (SAS), PT. Success Plasindo, and CV. Rigen Sarana Mukti in Surakarta, there were data gathered about competencies required to become an ideal production machine operator. From the data,
the formulation was performed to classify similar or cognate competencies. Based on the Focus Group Discussion inputs involving practitioners in machining and education, these competencies can be categorized into three groups of competencies: (1) base competency, (2) core competency, and (3) supporting competency of production machine operators.

Base competence of production machine operators is a combination of skills, knowledge, and proficiency in handling and acknowledging materials and processes of various objects related to machinery. This competency complements the core competencies required by the profession of production machinery operators. The presence of basic competence in a production machine operator is a prerequisite to becoming a proper operator.

Production machine operators’ core competence is the combination of skills, knowledge, and proficiency required to perform the tasks as a production machine operator with minor errors. This competence refers to some basic mandatory knowledge in the positions of specific production machinery operators. Supporting competency is a combination of skills, knowledge, and proficiency in terms of mental and attitude, personal quality expression, and the capability to work with others. A production machine operator has a caliber in providing more impressions on his/her profession.

3.1 Basic Competency of Production Machine Operators

Base competency is a set of skills related to and supportive of core competence. The presence of basic competence in a production machine operator is a prerequisite to becoming a proper operator. Basic competencies of production machine operators are as described in Table 1.

| No. | Unit of Competency                     | Explanation                                                                 |
|-----|----------------------------------------|-----------------------------------------------------------------------------|
| 1   | Understanding the technicality of      | 1. Explaining the types of metal materials                                  |
|     | materials                               | 2. Understanding the hardness and strength of materials                     |
|     |                                        | 3. Being able to choose the type of chisel based on the types of material worked on. |
| 2   | Using Measurement Instruments          | 1. Measuring with the instrument of precision mechanic                       |
|     |                                        | 2. Being able to use pneumatic measurement instruments                      |
|     |                                        | 3. Conducting maintenance of the measurement instruments                    |
| 3   | Utilizing Hand Tools and Mechanics     | 1. Utilizing various types of hand tools                                     |
|     |                                        | 2. Utilizing various types of powered tools                                 |
|     |                                        | 1. Interpreting and being able to draw the sketch                           |
| 4   | Reading the Technical Drawings         | 2. Describing technical drawings                                            |
|     |                                        | 3. Understanding processing symbols                                         |

From interviews and discussions with the head of the workshop, chief engine operator, and senior operator as well as questionnaires distributed to thirty (30) respondents within three machining workshops, the gap of basic competence is found between skills required in production machine operators and competencies possessed by VHS graduates of mechanical engineering. Results from discussion and questionnaires are presented in Fig. 2.
3.2 Core Competency
Core competencies are the primary skills related to the profession of the production machine operator. In searching for the core competencies amongst production machine operators' professions, they can be classified in Table 2. From interviews and discussions with the head of the workshop, chief engine operator, and senior operator and questionnaires distributed to thirty (30) respondents within three machining workshops, a gap of core competence is identified between production machine operators and VHS graduates in mechanical engineering. The results of interviews, discussions, and questionnaires are presented in Fig. 3.
Table 2 The core competencies of the profession of production machine operators

| No. | Unit of Competency | Explanation |
|-----|-------------------|-------------|
| 1.  | Working with Lathe Machine | 1. Understanding the setting mechanism of lathe machine  
2. Understanding how to capture the workpiece  
3. Understanding how the chisel works  
4. Being able to choose the kind of chisel most suitable with the material and the type of work  
5. Understanding how to give cooler/refrigerant in machining and to conduct maintenance of the cooling system.  
6. Being able to choose the machine parameters (speed of the spindle, feed, depth of lathe, etc.) compatible with the type and dimension of material worked on |
| 2.  | Working with Frais Machine | 1. Understanding the working mechanism of frais machine  
2. Understanding the capture mechanism of the workpiece  
3. Understanding the setting mechanism of the chisel  
4. Being able to choose the appropriate chisel due to the type and dimension of material worked on  
5. Understanding how to give more relaxed in the machining process and to maintain the cooling system  
6. Being able to choose the machine parameters (speed of the spindle, feed, depth of lathe, etc.) compatible with the type and dimension of material worked on  
7. Being able to conduct surface Frais  
8. Being able to perform graded Frais  
9. Being able to perform corner Frais  
10. Being able to perform flowing Frais  
11. Being able to conduct gearing Frais  
12. Understanding how to grind the Frais chisel |
| 3.  | Working with Grinding Machine | 1. Selecting gear wheel and the equipment  
2. Understanding the operating mechanism of grinding machine  
3. Checking components for specific compatibility |
| 4.  | Operating Lathe CNC Machine | 1. Installing fixture/equipment/holder tool  
2. Performing preliminary check  
3. Performing machinery setting of NC/CNC (Numerical Control/Computer Numerical Control)  
4. Being able to operate programming software  
5. Understanding the machining parameter  
6. Being able to select and setting chisel in CNC machine |
| 5.  | Operating CNC Frais Machine | 1. Installing fixture/equipment/holder tool  
2. Performing preliminary check  
3. Performing machine setting of NC/CNC (Numerical Control/Computer Numerical Control)  
4. Being able to operate programming software of NC  
5. Understanding machinery parameters  
6. Being able to select and setting chisel in CNC machine |
Figure 3 shows that it can be seen that the production machine operators require most of the competencies in the core competencies. There are less than 7% of students entirely, not knowing/having the appropriate core competency. Thus, the content of subjects taught at VHS in mechanical engineering has fulfilled basic competence demands as production machine operators. Hence, the problem that needs to be solved is: "why are five of the core competencies of most students still at a "less comprehension" level, i.e., more than 33%.

Thus, from the machine operators' basic competence map, the drawback of a mechanical engineering major in vocational school can be found. What needs to conduct is how to find solutions to the following problems:

1. On the core competency, why are VHS graduates placed in less comprehension category by the head of the workshop, chief engine operator, and senior operator?
2. What is the solution urgently needed to solve the problem related to improving the education system in mechanical engineering vocational high school?
Both of these problems will be further investigated in the second follow-up study of this research. Therefore, after obtaining competency maps and the existing gap, further research aims to solve the gap problem occurring on the competency map obtained.

3.3 Supporting Competency

Supporting competency is a set of skills related to the behavior and working attitude of automobile mechanics. Supporting competencies for professions of the production machine operator, car mechanics, and motorbike mechanics have similarities. This similarity is due to a service profession that is a service of reparation. Supporting competencies for the profession of production machine operators are described in Table 3.

| No. | Unit of Competency                                                                 | Explanation                                                                                                                                 |
|-----|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Comprehending and applying the safety, healthy, and security of working in the     | 1. Conducting safety, healthy, and security                                           |
|     | workplace environment                                                              | 2. Understanding the aspects of the secure working                                    |
|     |                                                                                     | 3. Operating the fire extinguisher tool                                                |
|     |                                                                                     | 4. Working on the obedience of Standard Operational Procedures                        |
| 2   | Comprehending and being able to do maintenance of working tools in the workplace   | 1. Conducting maintenance of tools and equipment in the workplace                    |
|     |                                                                                     | 2. Using the repairing kit and equipment                                               |
| 3   | Being able to perform good customer service                                         | 1. Being able to perform good communication with customers                             |
|     |                                                                                     | 2. Understanding ethics in serving customers                                          |

From interviews and discussions with the head of the workshop, chief engine operator, and senior operator and questionnaires distributed to fifty (50) respondents within the machining workshop, the gap of supporting competencies can be gathered between the requirement of the car workshops and competencies of VHS graduates. Discussion and questionnaires results are presented in Figure 4.

Figure 4 Graph of supporting competence comprehension of production machine operators from VHS graduates majoring in mechanical engineering
Supporting competencies of VHS graduates from machinery engineering – according to the head of the workshop, chief engine operator, and senior operator in the workshop – are in the low level of comprehension, especially in the unit competence of (1) understanding and being able to do maintenance of working tools in the working environment as well as (2) being able to perform good customer service.

4. Conclusion

Based on the competency map of production machine operators, it can be summarized that the gap competencies between the demands and competence of VHS graduates majoring in machining engineering are as follows:

1. In the base competency, according to the competency map of four-unit competencies, the most significant gaps between the graduates and the demand of the production workshop are (1) the competence of producing and reading the technical drawing and (2) the competence of using hand tools.

2. From the competency map, most of the unit competencies in the core competencies required by the production machine operators' profession are fulfilled. Students who do not master all unit competencies are only in a small proportion of lower than 7%. Therefore, the only problem that needs a solution is: "why is the level of competency of engineering vocational school graduates "less comprehension" positioned at more than 33% amongst five-unit competencies in the core competencies?"

3. Supporting competencies of VHS graduates of machinery engineering – according to the head of the workshop, chief engine operator, and senior operator in the workshop – are in the low level of comprehension, especially in the unit competencies of (1) understanding and being able to do maintenance of working tools in the working environment as well as (2) being able to perform good customer service.

Acknowledgments

This research was partly subsidized by the Grant of research PNPB Universitas Sebelas Maret 2020. The researchers gratefully acknowledge financial support from the LPPM Universitas Sebelas Maret Surakarta, Indonesia.

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