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Mapping Competencies of Vocational Teachers in the Industrial Era 4.0

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***Abstract*—Vocational education is currently the main topic of public discussion at the national education level. The main problem raised to the surface is the gap between graduates of vocational education and the absorption of national industry. The quality of graduate competencies that still do not meet the standards set by the industry while still having a low character, attitude and work ethic of the existing workforce. One of the components highlighted sharply regarding this issue is the capacity of human resources directly involved in the process of vocational education, namely professional vocational teachers. Moreover, entering the industrial era 4.0, the quality of professional vocational teacher competencies is very important to be a more in-depth and real study. Therefore, this study aims to describe comprehensively the efforts to improve the competence of professional vocational teachers in the digital era as an effort to meet the required competency standards. In addition, this study can systematically break down the tangled threads of vocational education that have occurred. The challenge of vocational education going forward is not only in the local, national and regional territorial dimensions, but also has a time dimension that continues to move forward with conditions constantly changing dynamically. For professional teachers, the vocational sector is very important to maintain and renew skills and knowledge in order to overcome the multi-dimensional dynamics of the world of work with a pattern of reform and increasing competition. Answering the challenges of this research will be conducted field observations to vocational high schools to find and explore data in the field. Observations were also made in various related industries to see empirically the vocational graduates in various industries and the labor market.**

Keywords—vocational teacher; competencies industry 4.0

I. INTRODUCTION

Professional skills of vocational teachers in the 4.0 industrial era are required to have a higher level of quality in a multi-dimensional manner within a tremendous physical, cyber system. Professional teachers as implementers of direct learning in class are required to have the ability to understand pedagogical theories and educational practices in schools in dynamic and multidimensional structures [1]. The process of achieving relevant professional competencies through a long process of academic education and experience in the industry. Extensive individual experience as a vocational teacher and work experience in the industry are partial parts which are essential components in enhancing professional abilities [2]. Teacher's general knowledge in the context of professional development is related to improving the implementation capability of tactical and strategic tasks. Investigate teacher's experience to identify common elements, so that they can perform complex and specific tasks including from a methodological point of view. Therefore, teacher knowledge competencies are useful to improve teacher education and make educational innovations more successful [3]. Transparency runs in the anatomy of job profiles, education and training curricula and regulations to anticipate the posture of the substance of the curriculum that continues to lag behind the evolution of technology [4]. The mechanism of the educational process in the 21st-century era in the context of human resource development has been arranged in the framework of a technology-based system and takes into account the increasingly tighter world economic competition [5]. It is difficult to refute in modern education that teachers are innovative, reformist and have

a vision for the future. Teachers with competency skills that develop continuously are an absolute requirement for professional work demands. Of course, besides the competence of knowledge and skills that must be possessed by a professional teacher, also must pay attention to personal and social aspects. Adaptation of teacher competence in a dynamic society involves three dimensions, namely sensitivity to the social life of the community, the background of life experiences that have been experienced and professional attitudes in various work situations [1]. Therefore, increasing the professionalism of work cannot be separated from the learning dimension, which includes individual structured learning with standard values that must be achieved. Then the next size is related to a comprehensive understanding of the institutional value system of the school organization. The final dimension is the influence of the environment outside the various relevant professional organizations. Institutionally on a broader scale, the three sizes above are better known as the learning process of three approaches, namely vertical learning networks, external learning networks, and horizontal learning networks [6]. The title is set in bold 16-point Arial, justified. The first letter of the title should be capitalized with the rest in lower case. You should leave 35 mm of space above the title and 6 mm after the title.

Professional development is one aspect of lifelong learning for teachers who understand the demands of their professional duties, both formally and informally. The substance of learning in the context of lifelong education, related to relevance testing ideas and theories and the learning process [7]. It is essential for individuals to re-examine their professional development and acquisition of new knowledge through a method different from what was known to date [8]. Lifelong education helps professional teachers not only to achieve new knowledge, but also to develop efficient thinking techniques, develop authentic learning and problem-solving skills, and have the capacity to achieve independence in new knowledge. Industrial needs and perspectives of a better future carrier develop broadly and indefinitely [9]. Competence is a characteristic that underlies individual performance in a particular job or situation superiorly. Capability becomes two significant parts of 'threshold competencies' competencies, namely the basic abilities of individuals in doing one job to achieve minimal goals and 'differentiating competencies,' namely the competencies that each person has with each other are functionally different. Another definition of competence states that competence is a characteristic or ability of individuals in carrying out specific actions, thus causing more effective performance. The essential skill is stronger because individuals perform operations that are repeated repeatedly on a particular job and become more active This process on a particular scale will be able to change, maintain and improve the skills, knowledge and positive attitudes towards the socio-cultural community. Changes in the culture that occur will increase leadership personality competencies, self-actualization, development of professional adherence, skills enhancement, knowledge acquisition, and creativity development. The 21st century is a century of a rapid growth of science and technology, which means significant changes in society and life culture in general. Many changes have emerged in the information society, economic restructuring and organizational reform and changes in existing elements of the work. The amount of new knowledge continues to increase, and the awareness that is left behind at high speed [10]. In general, the process of sustainable professional development is a fragmented, coherent activity that is not contextual and isolated from real class situations. The substance of sustainable professional development should have essential characteristics with patterns and structures as follows:(a) based on the concept of constructivism, not just transmission. (b) built in a long-term framework. (c) activities carried out contextually). (d) the process has a close relationship with educational performance reforms (e) Capable of self-reflection Characteristics of sustainable professional development for vocational teachers will provide a new color process related to a series of new knowledge and experiences. Competence of professional teachers of vocational technology or vocational education, focusing on high-quality teaching as the main prerequisites for high-quality education and training. Besides that, it also highlights the work of schools that prepare educational infrastructure with global adaptation competencies, complex environments, creativity, innovation, initiative, and entrepreneurship. Commitment to sustainable learning is as essential as the knowledge that specifically promotes the development of teacher competencies with universal competencies and heterogeneous classes.

II. Competence of Professional Teachers in Industry 4.0

Professional vocational teachers need to apply a new paradigm of thinking about industry 4.0, which is an integrated, holistic approach that tightly combines all elements to make their arrangements. The second new paradigm related to adaptation is the ability to interact with physical, cyber systems through complex and open communication technologies. The next new model of local culture is the ability of a physical, cyber system that is limited by the spatial nature of the environment, then the system dynamics that occur are not discrete, and are adaptive in that they have self-organizational abilities, such as learning, automatic and autonomous assembly. All of this offers not only unlimited opportunities to optimize production and supporting processes but can overcome the complexity of modern manufacturing automation [11]. Professional vocational teachers require comprehensive understanding and competence of essential elements of industry 4.0 which include: mobile devices, IoT platforms, location detection technologies, advanced human-machine interfaces, authentication and fraud detection, 3D printing, smart sensors, big data analytics and advanced algorithms, multilevel customer interaction and professional customers, augmented reality, and cloud computing. The connectivity device is connected to mechanical, physical devices. The aim is to receive and send data according to the order specified, both manually and automatically based on artificial intelligence. IoT devices in Industry 4.0 are known as the Industrial Internet of Things, which were previously very useful for internal monitoring. In the industry 4.0 concept, IoT devices can connect to WAN networks through a cloud environment. [12]. Arriving in the cloud environment, data can be processed and distributed to other parties. Here requires automation and orchestration in a hybrid cloud environment. One way is to use the DevOps approach that uses a containerization system to make it easier for developers and operational parties to continue to improve performance and services. The complexity of competencies that must be mastered is also increasingly multi-model and approach. The main issue of industry 4.0 is related to big data issues because all systems focus on 'human-generated data' not merely 'data supplied by machines or industrial data', in the form of engine controllers, sensors and manufacturing systems. Industry 4.0, involves intelligent, analytical devices and cyber-physical systems working together to realize new thinking in the industrialization process. Extensive data is input from the appropriate sensor installation and various signals such as vibration, pressure, and temperature. Also, historical data can be taken from further data mining through communication protocols, such as MTConnect and OPC, which can help users record controller signals. When all data is collected, this combination is called "Big Data" [13]. Transformation agents consist of several components: integrated platforms, predictive analytics, and visualization tools. The deployment platform was chosen based on calculation speed, investment costs, ease of deployment and renewal. The actual processing of large data into useful

information is the key to continuous innovation in Industry 4.0. [14,15].

Professional vocational teachers in the context of industry 4.0 need to have social competence referring to the fact that full digital integration and automation of all manufacturing processes in vertical and horizontal dimensions. So that the learning process in students is developed in the context of communication automation that requires communication skills, working together and building social connections and individual structures with other groups as one of the different dimensions of industry 4.0. Therefore, students as prospective industrial workers must understand the broader scope of the responsibility of the process and need the ability to understand the relationship between operations, information flow, overcome problems and be able to find comprehensive solutions. Increasing the scope and complexity requires a mindset that is oriented to the development of relationships and collaboration of experts in solving these problems the development of a digital 4.0 industry, autonomous and relying on artificial intelligence technology and working in a mechanical space, will undoubtedly make 'culture shock.' The role of humans in escalation will continue to shift the new value system, reduce labor, social interaction continues to diminish, public space is increasingly threatened, and the manufacturing process works with special procedures. Changes in the value system of the community, especially labor, which is more overtaken by machinery require various strategic efforts in the education process, especially in technology and vocational education [16].

III. Discussion

The study was conducted at SMKs in the Municipality of West Java to map vocational teachers related to competencies in the industrial era 4.0. Respondents were productive professional high school teachers as many as 95 people consisting of teachers in the Electricity Sector. Data collection from respondents is done directly from the primary data of respondents who have been determined in the previous sample. Data collection to all teachers who are respondents is also equipped with other instruments such as observation and interviews with parties that are relevant to the professional duties of the teacher. The composition of respondents comprised 78% of men and 22% of women which showed that male groups still dominated vocational teachers. The level of academic qualifications of respondents includes D-IV (2%), S-1 (72%), and S2 as much as 14%. Academically, the combined bachelor and master vocational school teachers meet the requirements of being able to increase competence, open new insights and develop various learning innovations in the industrial era 4.0. While the teaching experience of vocational teacher respondents is in the range of age 6 - 20 48%, generation of <6 -20 reaches 14% and > age of 6 - 20 as much as 28%. Data on teaching experience shows that respondents have been in the learning process for a long time with various models and curriculum content. So that the estimation of new learning processes that will be developed including in the industrial era 4.0 will be much more comfortable and can run well. The first indicators of the study are as follows:

Understanding the Concept of Industrial 4.0

- Obtain information on issues industry 4.0
- Doing Literacy Industrial 4.0
- Understanding physical, cyber systems
- Mastery of information technology related to 'big data'
- Understanding cloud computing
- Understand about virtualization and numerical computational modeling
- Autonomous automation and technology concepts
- The idea of robotization in the industry
- Internet of Thing (IoT) Concept
- The gross idea of a start-up-based business

The results of the study include two indicators, namely the understanding of the concept of industrial revolution 4.0 and the actualization of activities to increase competency related to industry 4.0 that have been and are being carried out by professional vocational teachers.

TABLE I. Understanding Industry 4.0

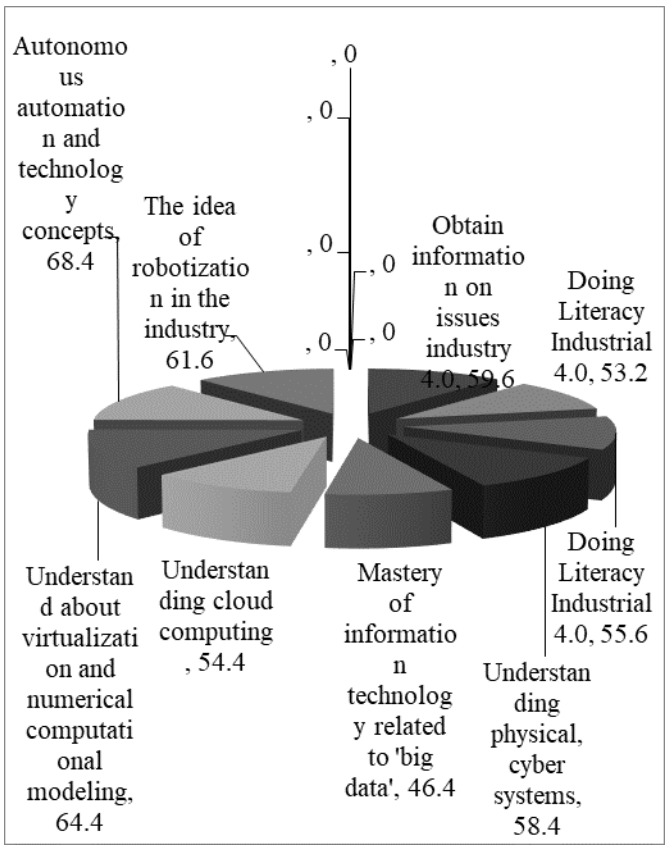


Table 1 shows the percentage of research results obtained on the first indicator. Use online media in the learning process is a sub-indicator reaching the highest value of 69.2% which shows that professional vocational teachers generally have used online media in the learning process quite high.

Multimedia devices that have developed rapidly in various learning activities and are widely available in schools make active teachers use this media. Activities that used to be offline have now shifted towards online, ranging from planning, preparation, implementation to evaluation of learning. In the second place, the highest achievement is the use of online media in the assessment of 67.6% which describes the most widely used evaluation activities online. Evaluation not only measures learning outcomes but also monitors in real time the entire learning process activities. Evaluation of vocational education content is more complicated than public schools, so various media, methods and assessment procedures are needed. The indicator with the lowest achievement related to understanding cloud computing is only 46.4%. Computing as a new phenomenon in industry 4.0 is included in its complex high-tech application which is a combination of the use of computer technology in a network with internet-based development. The primary function of cloud computing leads to the procedure of running programs or applications through computers that are connected at the same time in parallel. This cloud-based computer technology is a technology that makes the internet the central server for managing data and user applications. This technology allows users to run programs without installation and allows users to access their data via computers online. The characteristics of cloud computing that take advantage of these multiple functions make vocational teachers not yet comprehend comprehensively. Other indicators that are still low in the level of understanding of vocational teachers are those related to industrial 4.0 digital literacy activities which reached 53.2%. This shows the teacher's activity in reading various references and reading sources that discuss the industrial revolution 4.0 is still very lacking.

The second main indicator in this study is the activity of vocational teachers in developing a direct understanding of industrial revolution 4.0. In table 2 shows the overall implementation of professional vocational teachers in improving knowledge of the industrial revolution 4.0. Mastery of the highest sub-indicators of activities carried out by vocational teachers related to the concept of industrial robotization amounted to 68.4%. High achievement shows that vocational school activities related to the industry are actually in the field and have become academic traditions that must be done. One of the main doors towards this activity is to collaborate with relevant sectors in the form of sending students fieldwork practices (PKL). When the teacher guided the street vendors students, the involvement of these vocational teachers in the development of the latest industries that were all autonomous and made use of robots in the production process increased significantly. Even teachers in updating teaching materials and learning tools are required to seek and reveal in depth the latest technologies. The most worrying is that the percentage of workshops on the use of ICT in IoT is only 42.4%, which shows that most professional vocational teachers do not understand comprehensively what is called the Internet of Thing (IoT). The widespread use of the internet in the context of learning has not become part of the learning revolution in the industrial era 4.0. Internet of Thing is still a new phenomenon that has not been comprehensively understood by vocational teachers, both in the learning process and outside.

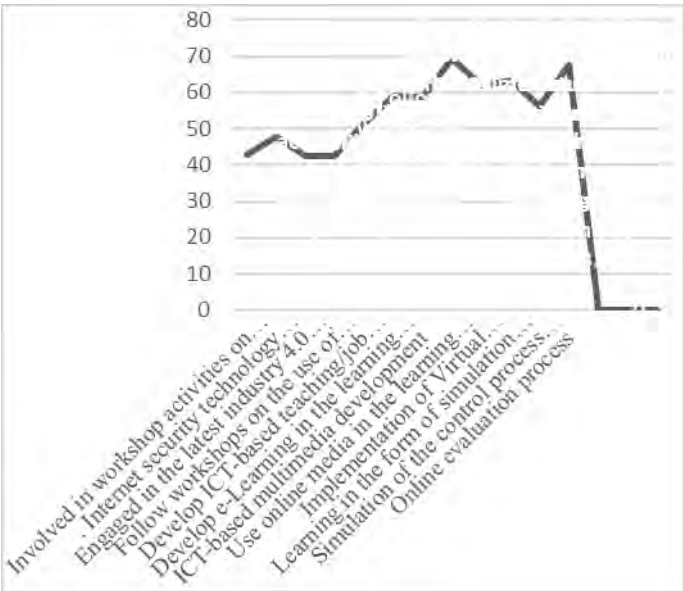
The second indicators of the study are as follows:

The actualization of Activities for Understanding the Industrial 4.0

- Involved in workshop activities on industrial 4.0
- Internet security technology activities
- Engaged in the latest industry 4.0 product exhibition
- Follow workshops on the use of ICT in IoT
- Develop ICT-based teaching/job sheet materials
- Develop e-Learning in the learning process
- ICT-based multimedia development
- Use online media in the learning process

The results of the second indicators are as follows:

TABLE II. UNDERSTANDING ACTIVITIES INDUSTRY 4.0



IV. CONCLUSIONS

- Mastery of industry 4.0 concepts in professional vocational school teachers is still low related to the substance of the internet of things, cloud computing, big data, autonomous ideas and physical, cyber systems
- Vocational teachers, in general, have more control over e-learning and other online media.
- Increasing industry 4.0 competencies must be immediately implemented as a provision for teachers to provide more up to a dated subject matter.

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