**Vocational High School Teacher Readiness: Industrial Revolution 4.0 and 21st Century Education**

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**Abstract.** This research synthesizes study findings on teacher readiness in facing the industrial revolution 4.0 and the demands of the 21st century education skills. This research studied journals articles from 2015 to 2019. This paper focuses on the problem of vocational teacher preparation in facing the industrial revolution 4.0 and the 21st century vocational learning. The Era of industrial revolution 4.0 brought significant changes in all aspects, including education. Vocational high school is an education that has the task of producing students who are ready to work skillfully in industries. Increasing student competence to face industrial revolution 4.0 and the demands of the 21st century education skills is one of the challenges for teachers. Therefore, as a solution to this problem, it is necessary to explore a study on the Readiness of Teachers in the face of the industrial revolution 4.0 and the demands of the 21st century education skills. From some of the studies that have been carried out, technology literacy and technology integration are competencies that must be possessed by teachers in facing the industrial revolution 4.0 and the demands of the 21st century education skills.

1. **Introduction**

The industrial revolution 4.0 is marked by the wave of sophisticated technology and the emergence of various digital industries through the transformation of 9 pillars of sophisticated technology [1] [2]. The challenges of knowledge and competence that are closely related to the era of disruption and the industrial revolution 4.0 require a new strategy to prepare Human Resources (HR) that can compete and meet a variety of needs that keep evolving [3][4].

Vocational High School is an educational institution designed to prepare students or graduates who are ready to enter the job market and are able to develop professional attitudes in the vocational field. Graduates of vocational education are expected to be productive individuals who are able to work as middle level workers and have readiness to face work competition. Vocational education graduates indeed have qualifications as (prospective) workers who possess certain vocational skills relevant to their fields of expertise. In facing the challenges of the Industrial Revolution 4.0, vocational high schools (SMKs) must continue to develop dynamically and be able to organize competency-based education.

Various competencies of expertise that exist in vocational secondary education must begin to consider new strategies in fierce competition between robots and humans, such as human-machine cooperation that will be widely used by *smart factory* [5][6]*.* So it is necessary to pay attention to the various competencies prepared by vocational schools to produce graduates who can compete and pay attention to the relevance of competencies of expertise with the conditions of dynamic and rapid industrial development based on industry needs in the midst of the industrial revolution 4.0 and various challenges and shifts that occur in this disruption phenomenon. Rapid technological advances need to be balanced and be mastered by each teacher. Nowadays, information is easily obtained from anywhere through internet facilities.

In the era of Education 4.0 as it is today, the learning process is not only done conventionally but is starting to shift to a technology-based learning process [7]. Each school attempts to integrate technology according to their individual needs. The existence of integrated technology in school will greatly facilitate the learning process and increase student competency. E-learning, e-administration, virtual laboratories, and web sites are some examples of technology integration in the school environment [8]. In addition to integrating technology, 21st century learning is a solution that educators can do in improving students' skills as a provision in facing industry 4.0 [9].

21st Century learning is characterized by learning Learning skills, skills and literacy. Learning skills are learning activities which are marked by cooperation, communication and critical and creative thinking. Skill is the ability of someone to do something that is specific, focused but dynamic that requires a certain amount of time to learn and can be proven. While literacy is the process of exposure or transfer of information to provide understanding for people who are learning and trying to understand something [10]. The field of education hopes that by implementing the 21st century learning it will produce graduates within productive age generations who have great quality and skills in order to face the challenges of the industrial revolution 4.0 [11].

This research aims to examine the readiness of teachers in facing the industrial revolution 4.0 and the 21st century learning. Educators and researchers can use this information to identify unanswered issues or questions in the literature and define the direction of future research regarding the readiness of teachers in facing the industrial revolution 4.0 and the 21st century learning.

1. **Methods**

Literature review was identified by browsing the Web of Science database, followed by exploring Scopus database by entering the keywords "*21st century education*" and "*industrial revolution 4.0*". 20 relevant articles were obtained and read, analyzed and coded using a spreadsheet program.

**Coding Scheme**

The coding scheme was adapted from a structured / systemic approach to the literature review. The approach used four main categories in analyzing articles, namely the following:

1. Basic data: author, year of publication, journal, location of study
2. Research methods: research approaches, methods, themes, data collection, method of analysis, research results
3. Content analysis: industry revolution 4.0, 21st century education, ICT literacy, content areas and designed pathways (i.e., how researchers / educators prepare education for students in the face of the industrial revolution 4.0 and the 21st century learning)
4. Discussion: issues discussed, future instructions, personal comments
5. **Literature Review Result**

*3.1. Industrial Revolution 4.0*

Industry 4.0 was first coined at the Hannover Fair in 2011, and the term has attracted a lot of attention from various groups, ranging from academics, practitioners, government officials, and politicians around the world. Industry 4.0 is a current trend towards automation and data exchange in manufacturing technology. This includes cyberphysical systems, the Internet of Things, and cloud computing [12]. Industry 4.0 creates what is referred to as a "smart factory". In a modular, structured smart factory, the physical system monitors cyber-physical processes, makes virtual copies of the physical world, and makes decentralized decisions. The Internet of Things refers to cyberphysical systems that communicate and work with each other and with humans in real time through internet services, through which both internal and cross-organizational services are offered and used by participants throughout the value chain [13]

In addition, the 4.0 industrial revolution will show the dependence of industry and work environment on the *Cyber Physical System* (CPS) and its implementation on *smart factory* [2]*.* Various aspects include the most important expertise competencies that will be much affected by the industrial revolution 4.0 [14] accompanied by the rapid phenomenon of disruption. Workers in the future will be highly demanded to have a high level of skill and proficiency in the use of various CPS-based technological advances which are clearly very different from the current industry conditions [15][16], [17].

The Industrial Revolution 4.0 is a change in the industrial system better known as industrial automation. Industrial automation has the effect of loss off many jobs, in addition to the emergence of many new types of jobs that emphasize 21st century skills. The 21st Century skills include critical thinking skills, creativity, collaboration, and communication [11]. These four competencies will play an important role in facing the industrial revolution 4.0. Industry 4.0 as a phase of technological revolution that changes the mindset and way of one's activity in the scale, scope, complexity, and transformation from the previous phase [18]. All layers must be able to quickly respond to the industrial revolution 4.0. Such responses involve all global political stakeholders, ranging from the public sector, private sector, academia, to civil society. Especially in the field of vocational education, the challenge of the industrial revolution 4.0 is an opportunity to improve the quality of vocational education to be more optimal.

*3.2. The 21st Century Learning*

The 21st century is known to everyone as the age of knowledge which is the main foundation for various aspects of life. The 21st century learning paradigm emphasizes the ability of students to think critically, be able to connect science with the real world, master information technology, communicate and collaborate [19]. These skills can be achieved by applying appropriate learning methods in terms of mastery of the material and skills.

The development of the media of information technology has become one of the basic foundations in the development of 21st century learning. Media of information technology seem to be a mandatory factor to be used in everyday life. 21st Century learning requires a thorough transformation of education to build the quality of teachers who are able to advance knowledge, training, student equity and student achievement [20].

21st century learning focuses on the formation of digital-based learning, the ability to learn and to innovate, and the development of life skills. More specifically, learning conducted by teachers must be oriented to the development of four core skills: critical thinking and problem solving skills, communication skills, collaborative skills, and the ability to create new things (creativity) [21].

Integrating ICT in the learning process requires planning on the application of ICT as a transformation in learning [22]. Education system needs to renew and reform teacher preparation and professional development gradually, and ensure that all teachers can utilize technology in the process of learning. The development of an ICT competency framework for teachers (ICT-CFT) as an effort to help develop and improve teacher ICT competency standards comprehensively developed by UNESCO is as follows:

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| **Table 1.** 21st Century Skills Framework for Teachers. |

|  | **Technology Literacy** | **Knowledge Deepening** | **Knowledge Creation** |
| --- | --- | --- | --- |
| **Understanding ICT in Education** | Policy awareness | Policy understanding | Policy innovation |
| **Curriculum and Assessment** | Basic knowledge | Knowledge application | Knowledge society skills |
| **Pedagogy** | Integrate technology | Complex problem solving | Self-management |
| **ICT** | Basic tools | Complex tools | Pervasive tolls |
| **Organization and Administration** | Standard classroom | Collaborative groups | Learning organization |
| **Teacher Professional Learning** | Digital literacy | Manage and guide | Teachers as model learner |

The framework listed in table 1 is arranged in three different approaches to teaching. Technology Literacy allows students to use ICT for learning more efficiently. Knowledge Deepening enables students to gain in-depth knowledge of their school subjects and apply them to complex real-world problems. Knowledge Creation allows students to create new knowledge needed as a solution in dealing with problems that occur [22].

As a supporting tool in the implementation of 21st century learning, teachers need a toolkit, which is a learning resource used to introduce information and communication technology (ICT) in the learning process [22]. This learning resource utility includes the creation of ICT in learning strategies, considering learning approaches, designing curriculum, and ICT-based learning materials as a source of student learning. The toolkit is used by teachers to support 21st century learning, as a solution in dealing with the industrial revolution 4.0

*3.3. Technology Literacy*

Technology literacy as one of the frameworks in 21st century learning is a mandatory to be mastered teachers. Every teacher must be able to hone the ability to use technology in learning. Technology literacy is the ability to use, understand, manage and assess an innovation that involves processes and science in solving problems [23]*.* As a teacher who has a level of technological literacy, he/she will have an understanding of technology at a level that allows effective utilization [24]*.* The ability of technology literacy is generally divided into two perspectives, the first is the basics of ICT knowledge which includes concepts and understanding of theoretical principles regarding computers, information systems, digitization, programming, technological limitations and social impacts. Second, perfective ICT skills include understanding and ability to use ICT [24].

Technology literacy is the ability to use digital technology, communication tools / networks to access, manage, integrate, evaluate and make information as knowledge [25].

|  |  |
| --- | --- |
|  | Access  Manage  Integrate  Evaluate  Create |
| **Figure 1.** Increasing Complexity of Knowledge and Expertise ICT Literacy | | |

The stage of component in the formation of technology literacy represents a set of skills and knowledge presented in sequence. The sequence shows a gradual increase in cognitive complexity. Each stage has a significant role, the first stage is access: knowing about how to collect and obtain information; manage: implement the organization and manage it using a scheme as well as file data and information that has been obtained previously; Integration: interpreting information consisting of analyzing and searching from various other sources and comparing that information; evaluate; make judgments about the quality, relevance, usefulness and efficiency of information; make: this stage is the final stage, namely adapting, applying, designing, creating from the information that has been obtained and analyzed [25].

In a global understanding, technology literacy is an understanding of technology at a level that allows effective use in modern technology which consists of three main components, namely knowledge, abilities and critical thinking, and decision making [24]. Technology literacy can be interpreted as an ability consisting of aspects of science, critical thinking skills, and decision making in an effort to use technology / innovations of human works effectively, especially in the world of education. In this 21st century learning, teachers are required to be able to use internet access or online teaching materials [11]. In addition to being able to use ICT as a source of learning, teachers are also required to be able to create creative and innovative learning that is integrated with ICT (Information and communication technology) [26].

*3.4. Technology Integration*

The 21st century learning process, which integrates information and communication technology as a tool in an effort to achieve learning process that prioritizes 21st century skills and abilities that must be possessed by students [11]. Information and Communication Technology (ICT) has become the most fundamental requirement of modern industrial society in a very short time. The mastery and integration of ICT in the learning process is an advantage possessed by a teacher [27]. Information technology-based technology tools or applications support student activities in the learning process to achieve 21st century skills such as creativity, innovation, communication, collaboration, information and media literacy, and so on [28][29].

In the implementation of learning, ICT tools can be used as a means to enhance student creativity [26]. Students can utilize information and communication technology facilities or computer applications in their learning activities such as Internet technology which can be used by students as learning resources [30]. By using internet technology, students can access learning resources on the internet by utilizing web pages that provide information needed by students [31]. With internet technology, students can access various information needed relevant with the learning material discussed in learning at school, thus training students' independence in finding information needs and increasing student creativity in gathering information from various sources that can be used as learning sources [26]

1. **Conclusion**

The integration of ICT and digital competence are a necessity to be mastered by 21st century teachers. In the industrial revolution 4.0 era as an era of shifting towards digital technology, learning process is not only carried out conventionally but it begins to shift to a technology-based learning process. Industrial Revolution 4.0 provides a change in educational innovation. Industry 4.0 prepares graduates for more complex jobs where smart robots will replace humans in certain divisions of activities. The currently developing Information and Communication Technology which is accessed as one part of 21st century skills and competencies must be possessed by everyone, especially by teachers as educators in schools. By having 21st century skills competencies specifically using information and communication technology can help in developing student learning in an effort to achieve 21st century skills such as communication skills, collaboration, creativity, innovation, independence and so on.

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