

Design and Technology for the Future: RBT Teacher Competence Facing the Industrial Revolution 2.0": Systematic Literature Review

Nurul Syuhaiza Othman, Ridzwan Che' Rus, Ainul Kamaliah Nasri

Faculty of Technical and Vocational, Sultan Idris Education University, 35900 Tanjung Malim, Malaysia

Corresponding Author Email: nurulsyuhaiza.othman@gmail.com

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Abstract

In the face of the Industrial Revolution 4.0 era, teacher competence plays an important role in ensuring the effectiveness of the education system. The study discusses the competencies required by teachers to prepare their students for the challenges and opportunities from technological advancements and technological changes in the industry. This study aims to conduct a systematic literature review on research trends and identify the competence of design and technology (RBT) teachers in facing the Industrial Revolution era 4.0. Prisma Model was used in this study. The results of two search engines, SCOPUS and Mendeley, found that the number of articles increased from 2019 to 2023. This shows that education during the era of Industrial Revolution 4.0 is increasingly gaining attention among researchers. The findings show that researchers are more interested in implementing studies using quantitative methods than qualitative or mixed. The questionnaire survey method is a popular method used to assess the competence of teachers needed to cope with these changes. In addition, the results also show the necessary competencies include technological competence, pedagogical competence, attitudinal competence, social competence, professional competence and general competence(general). Therefore, the findings of this study can be used as a guide in implementing teaching and learning in the era of Industrial Revolution 4.0.

Keywords: Teacher Competencies, Industrial Revolution 4.0, Digital Era, Challenges

Introduction

The Industrial revolution 4.0 has changed the paradigm of the world with bring a big change comprehensively in human life which lead us to a new era of digital communication. This change is driven by the rapid technological development, including *Internet of Things* (IoT), Artificial Intelligence (AI), processing *big data*, robotics, and automation that covers the field of engineering, production as well as product design. In line with these changes, the field of

education is no exception the face of changes in the context of teaching and learning, skills as well as approaches to the teaching. Here, the teacher plays an important role in guiding students understand the importance of this shift mainly in the field of Design and Technology. In addition, the subjects of the RBT is also an important element in the Industrial Revolution 4.0.

The study "Design and Technology for the Future: Competencies Teacher RBT Face the Industrial Revolution 4.0" examines how teachers can prepare themselves and develop the competencies required to meet the demands of globalization that is constantly evolving. This study looked at how the role of the teacher changed from the delivery of information to facilitating learning, helps students develop 21st century skills such as problem solving, creativity, collaboration, and critical thinking. Teachers not only need to have a deep understanding of the subjects taught, but also be able to integrate technology into learning, in addition, promote learning-centered disciples, teach digital skills required. Teacher of Design and Technology requires competency high and deep to teach their subject effectively and adapt to change the world.

RBT has an important role in nurturing the creativity of students in innovative solutions that are relevant to social needs and industry. By integrating elements of design and technology in teaching, the teacher is able to stimulate the creative thinking as well as innovative among pupils, helping them develop the skills needed in the job market is constantly experiencing changes (Mishra & Koehler, 2006). Commitment to integrate the field of design and technology in the education curriculum is important to ensure teachers are trained with the knowledge and skills up to date. This is not only beneficial to the teachers, but also ensure the next generation has a solid base in the face of opportunities and challenges associated with the Industrial Revolution 2.0.

Highly competent teachers will produce high-quality pupils (Tsymbaliuk et al., 2019; Turu et al., 2022). In fact, teachers who are skilled in the use of technology can create an atmosphere of learning that is more interesting and relevant to a generation of students who grew up in the era of digital. In the meantime, the teacher has the competencies that are high in design and technology to be able to organize their teaching to meet the needs of the industry, to ensure high marketability for the students. Therefore, this study was conducted with the aim of summing up systematically required competencies such as year of publication, the approach of the study as well as competency in the context of the teacher in the face of the Industrial Revolution 4.0. Thus, a systematic survey is carried out based on the guidelines of the model of *Systematic Reviews and Meta-Analyses* (PRISMA). This study was conducted to answer the question as follows:

- i. What are the research trends such as year of publication, country and study approach used for RBT teaching and learning research ?
- ii. What is the competence of RBT teaching and learning implementation in the face of the Industrial Revolution?

Method: Systematic Literature Review

To address the objective of this research, we carried out a systematic literature review (SLR), which is a rigorous method to provide an overview of a particular research field and the results it has produced. This approach has a growing trend for past years due to some reasons. SLRs address involves knowledge in various fields because future research can be improved based on the findings of this study (Page et al., 2021). This systematic literature review is also source

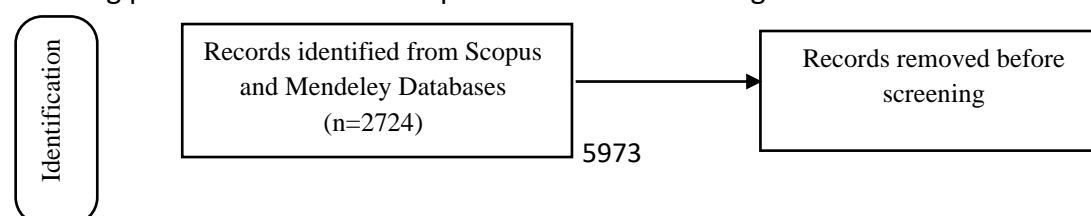
of new knowledge that allows researchers to understand the details of the study, and identify further research gaps (Hayrol Azril et al., 2020). In addition, this systematic literature review also aims to find and synthesize information through research carried out using systematic, transparent and replicable procedures through the steps carried out (Higgins et al., 2011). Apart from that, SLRs also aims to find and synthesize information through research carried out using systematic, transparent and replicable procedures through the steps carried out (Higgins et al., 2011).

The selection of SLR articles must go through three stages, namely Identification, Screening, and Eligibility, as proposed in the PRISMA model. This three-stage process ensures that the researcher carefully collects information, evaluates the quality of the study, and systematically analyses the results of the study. The resulting literature highlights will provide a clear and organized view of scientific developments in a particular field and help guide future research. To ensure that the article used is relevant to the title of the study, three main keywords from the study question were used, namely “teacher competence”, “Industrial Revolution 4.0” and “challenges”. The search for articles is carried out through two electronic databases SCOPUS and Mendeley. These two databases are considered to be the most robust and widespread sources of publishing information and publication metrics. From the selected database, a total of 2724 articles were identified, of which 1761 from the SCOPUS database and 963 from the Mendeley database.

During screening phase, a total of 832 articles were selected at the next stage. For this purpose, an open access journal is used in the search performed on the selected database. Due to changes in technology, this study only refers to the last five years of 2019-2023 to identify relevant articles used. Moreover, some selected articles were removed from the list when they were not relevant to the required information. The results of the screening of 641 related articles that have been selected after making several removal of articles, namely 161 articles without full access. Subsequently, the articles will be examined further to determine if they are worthy of being selected or not. Six themes will be discussed in this study, including the country where the study was conducted, the design of the study, the instruments used, the population and sample of the study, as well as the competencies required in the era of Industrial Revolution 4.0.

The final stage for systematic literature highlights is to include articles that are relevant to the theme and title, followed by the synthesis step on the selected articles at the final stage. This article was revised by filtering headings and abstracts to narrow down and exclude articles that are not related to teacher competence and the Industrial Revolution 4.0. Articles using the term Industrial Revolution 4.0 and teacher competence but does not explain in depth about these two aspects, and does not focus on aspects of competence will be removed. A total of sixteen articles that did not meet the established criteria were removed from the final article list.

Finally, 14 working papers have been selected to represent the competence of teachers in the face of the Industrial Revolution 4.0. Fourteen selected and eligible for inclusion in the literature spotlight were systematically classified according to two criteria, namely, articles focusing on teacher competence in the era of the Industrial Revolution 4.0, but not specifically focusing on the careers of RBT teachers (Primary, Secondary, Higher Education). Next, an article that explicitly discusses the skills of the Industrial Revolution 4.0 required for the teaching profession. The next step is to conduct a thorough review of these articles.



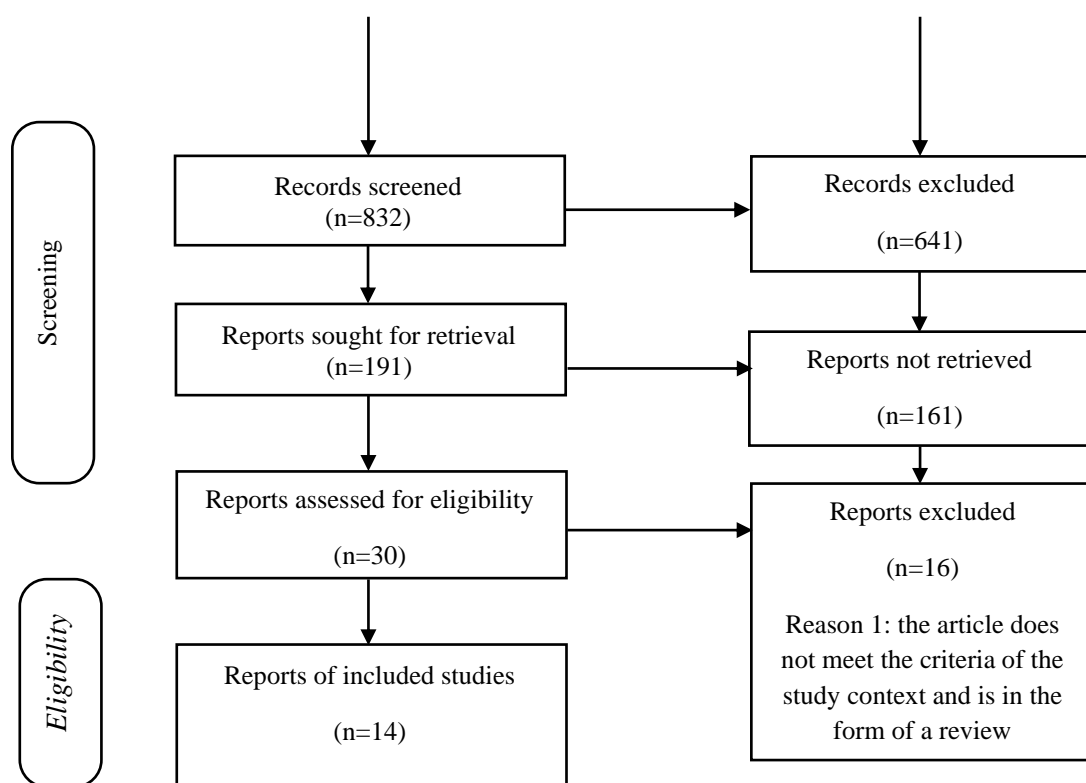


Figure 1: Systematic literature spotlight process flow chart based on PRISMA Model

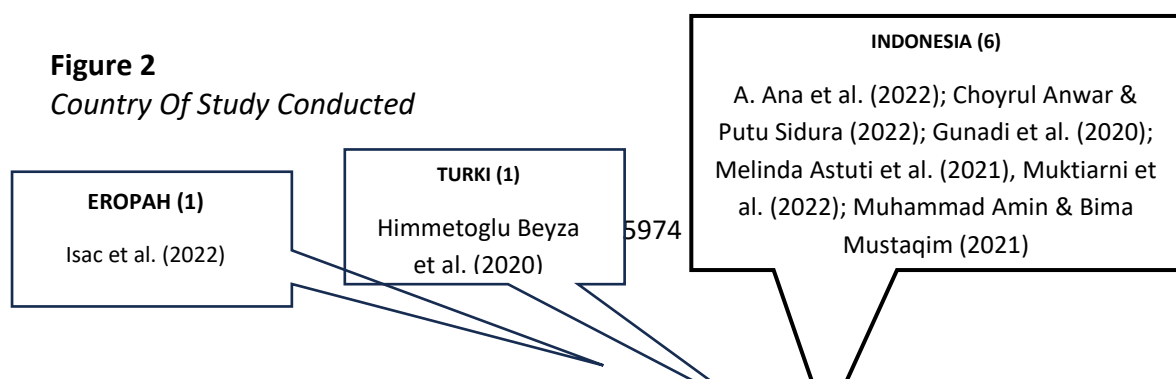
Study Results

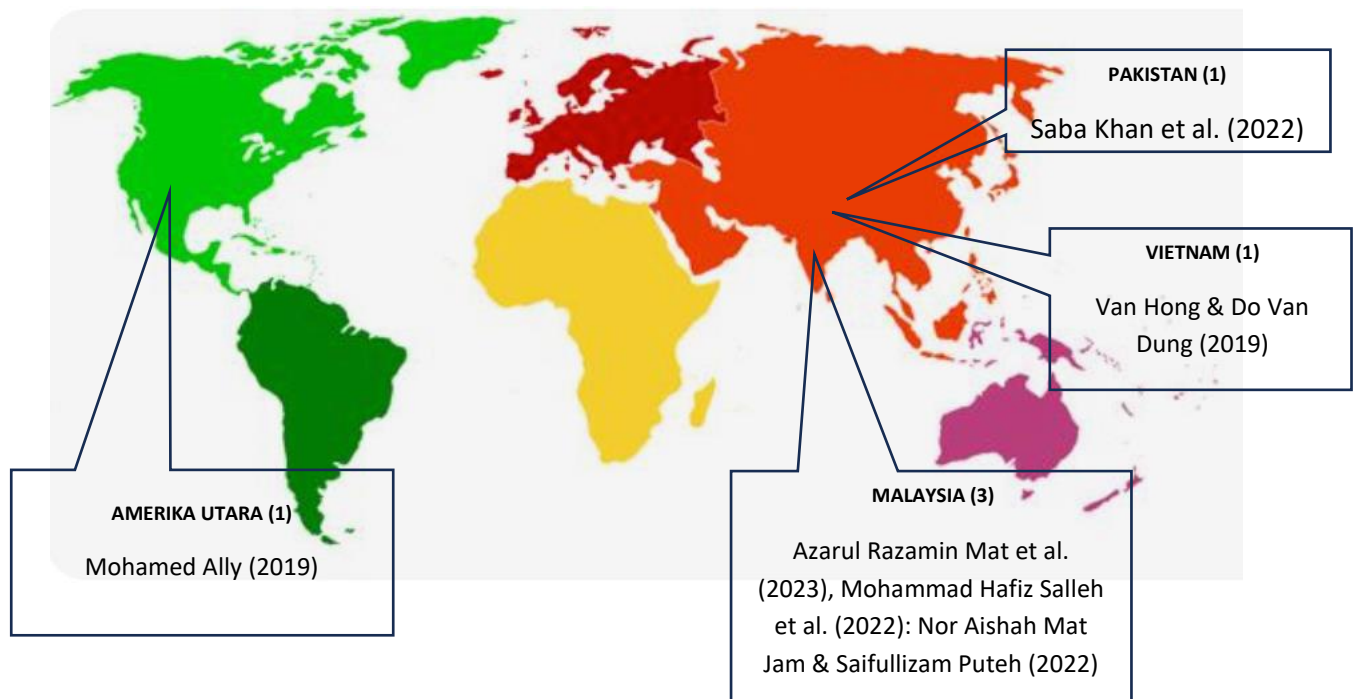
The results of the study are detailed as follows:

Country Of Study

There are seven countries that conducted a study related to the challenges facing the Industrial Revolution that affect the competence of teachers. Based on Figure 2, Indonesia conducted six studies conducted by A. Ana et al. (2022); Choyrul Anwar and Putu Sidura (2022); Gunadi et al. (2020); Melinda Astuti et al. (2021), Muktiarni et al. (2022); Muhammad Amin and Bima Mustaqim (2021). Three studies were conducted in Malaysia by Azarul Razamin Mat et al. (2023), Mohammad Hafiz Salleh et al. (2022); Nor Aishah Mat Jam and Saifullizam Puteh (2022). In addition, a study was conducted in Belgium (Isac et al., 2022); Canada (Mohamed Ally, 2019); Pakistan (Saba Khan, 2022); Turkey (Himmetoglu Beyza, 2020); and Vietnam (Van Hong & Do Van Dung, 2019). Ten studies represent 86% of the total studies conducted on the Asian continent, while the rest representing 14% studies were conducted in Western Europe and North America. The list of countries and researchers conducting the study is as follows

Figure 2
Country Of Study Conducted





Study Design and Instrument

The design of the study was analyzed using descriptive method to obtain the total percentage. As a result, a total of five studies used a qualitative approach of 36%. Eight of the studies used quantitative methods, accounting for 57% of the overall study, and one study used a combination of qualitative and quantitative methods that accounted for 7% of the overall study. This figure makes the design of the quantitative study the highest in this systematic literature review. Qualitative study design conducted using case studies conducted by Azarul Razamin Mat et al. (2023); Himmetoglu Beyza et al. (2020); Mohamed Ally (2019); Nor Aishah Mat Jam and Saifullizam (2022); Van Hong and Do Van Dung (2019) to study the competence of teachers in facing the challenges of the Industrial Revolution 4.0 while eight studies by A. Ana et al. (2022); Choyrul Anwar and Putu Sudira (2022); Gunadi et al. (2020); Melinda Astuti et al. (2021); Mohammad Hafiz Salleh (2022); Muktiarni et al. (2019); Muhammad Amin and Bima Mustaqim (2021) and Saba Khan et al. 2022 uses a quantitative study design that is a questionnaire. A combined qualitative and quantitative study design is a study conducted by Isac (2022) using interviews, observations and questionnaires.

Study Participants

The study participants involved in this competency study consisted of teachers, namely among primary schools, secondary schools or vocational colleges. The number of participants participating in the study is shown in Table 1.

Table 1
Respondents

Researchers	Number Respondents	Of	Study Participants
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Choyrul Anwar & Putu Sudira	168	Teacher
Mohamed Ally	34	Teacher
Muhammad Amin & Bima Mustaqim	166	Teacher
Gunadi et al.	71	Teacher
Nor Aishah Mat Jam & Saifullizam Puteh	7	Teacher
Melinda Astuti et al.	233	Teacher(82), Student(181)
Van Hong & Do Van Dung	-	-
Mohammad Hafiz Salleh et al.	400	Teacher
Azarul Razamin Mat et al.	-	-
Himmetoglu Beyza et al.	10	Teacher
Saba Khan et al.	458	Teacher
Muktiarni et al.	13	Teacher
A. Ana et al.	356	Teacher
Isac et al.	557	Teacher

Competency

To answer the second study question, the competence of RBT teachers in facing the era of Industrial Revolution 4.0 has been analyzed based on systematic literature highlights. In the world of education, teachers play an important role in spearheading the Industrial Revolution 4.0 because they are educators who play an important role in shaping the future of education and preparing students to face the increasingly complex digital world. Teachers are still role models in the classroom, but their role has evolved into facilitators of learning. This is because they have a responsibility to create a proactive environment, acquire knowledge independently, solve problems, and think critically and creatively. In doing so, teachers not only impart knowledge but also guide and encourage students to think critically and creatively while actively participating in the learning process.

Therefore, teacher competence is an important aspect of the education system and student development. Teacher competence refers to the combination of knowledge, skills and attitudes required to provide quality teaching and effectively shape student development (Cakrawati et al., 2015). These competencies include technological literacy, accessibility, critical thinking, creativity, problem-solving skills, and the ability to foster collaboration and communication among students. To meet the requirements of the Industrial Revolution 4.0, teachers must continuously improve their professional standards and keep abreast of the latest developments in technology (Spoettl & Tutlys, 2020).

There are six competencies required by teachers in facing the challenges of the Industrial Revolution 4.0, the first is technology competencies such as mastery of educational software (e-learning), multimedia skills, digital information management and web-based learning. Second is the pedagogical competence associated with the skills to plan, control and evaluate teaching and learning. The third is personal attitude competence which includes the nature and attitude of teachers as role models, establish good relationships with students and create a conducive learning environment. Fourth is the social competence associated with the skills and attitudes of teachers to interact and communicate effectively with pupils, peers, parents and other stakeholders in the educational context. The fifth competency involves professional competence which is a combination of individual abilities, technological knowledge, social and

spiritual. Finally, it involves general competencies (general) also known as "generic skills", or "basic skills" for example skills in time management, and collaborative competencies.

Technological competence is key to meeting the challenges of the Industrial Revolution 4.0. Today, digital technology and artificial intelligence are increasingly dominating and rapidly changing the educational landscape, where teachers need relevant knowledge and skills in technology to perform their roles more effectively. According to a study by Azarul Razamin Mat et al. (2023); Himmetoglu Beyza et al. (2020); Choyrul Anwar and Putu Sudira (2022); Gunadi et al. (2020); Melinda Astuti et al. (2021); Mohamed Ally (2019); Muhammad Amin & Bima Mustaqim (2021); Nor Aishah Mat Jam and Saifullizam Puteh (2022); Saba Khan et al. (2022), teachers need to prepare themselves to keep up with technological developments and be willing to adapt technological changes relevant to their teaching such as the Internet of Things (IoT), Artificial Intelligence (AI), big data processing, robotics, and automation that revolutionize the way they interact, work and learn. In fact, it also includes knowledge and skills in using learning software, managing online learning platforms, and applications that can extend the learning experience of students during teaching and learning. Because of this, teachers who are proficient in technology can take advantage of various online learning resources such as accessing e-books, learning videos, and educational websites.

Teachers with a high level of pedagogical competence are skilled at designing lessons that are relevant to current needs and developments. In this context, pedagogical competence involves the knowledge and skills of teachers in planning, delivering and evaluating lessons, taking into account changes brought about by technology, globalization and changes in industrial skills requirements (Azarul Razamin Mat et al., 2023; Himmetoglu Beyza et al., 2020; Melinda Astuti et al., 2021; Muktiarni et al., 2019; Mohamed Ally, 2019; Mohammad Hafiz Salleh et al., 2022; Saba Khan et al., 2022; Van Hong & Do Van Dung, 2019). The pedagogical competence of teachers is a very important aspect in facing the challenges of the industrial revolution besides playing a role in providing teachers with relevant knowledge and skills in helping them cope with the changes brought about by technological development and the Industrial Revolution 4.0 (Puspa et al., 2022). The teacher's pedagogical competence in facing the challenges of the Industrial Revolution also includes the ability to implement technology-based learning, utilizing the Internet of Things as the basis of teaching (Himmetoglu Beyza et al., 2020).

The competency also discussed by the past researchers was the competency of teachers' attitudes in facing the challenges of implementing teaching in the era of Industrial Revolution 4.0. The competence of teachers' attitudes include their willingness and commitment to teaching, their approach to changes in education and technology, and their attitude toward pupils, which includes patience, empathy, and integrity (Himmetoglu Beyza et al., 2020; Muktiarni et al., 2019; Mohamed Ally, 2019; Saba Khan et al., 2022). Not only that, teachers need to cultivate a lifelong learning attitude, which means they are open and willing to continue to learn and update their knowledge and skills from time to time. This includes a willingness to take courses, internships, or deepen developments in the field of education.

Social competence refers to the skills and interpersonal qualities of teachers in interacting with pupils, colleagues, parents and other stakeholders in education. In fact, it enables teachers to deliver lessons that enhance pupils' critical thinking, analytical skills, and in-depth understanding, which are fundamental to their academic and professional development (A. Ana et al., 2022; Muktiarni et al., 2019). Teachers with a high level of social skills are able to create a positive and supportive classroom environment where students feel valued and

respected. In addition, according to A. Ana et al. (2022) teachers who have good manners, high empathy, a good relationship is established between teacher-student is very important in education and daily life.

The Industrial Revolution 4.0 requires highly qualified skilled workers, hence the focus of education is to provide human capital that meets the needs of the industry. Therefore, teachers need to have professional competence to achieve several important goals in the field of education as has been emphasized in the Malaysian teacher Standard 2.0. This issue was discussed in a study by A. Ana et al. (2022); Isac et al. (2022); Muktiarni et al. (2019), which includes specific knowledge in their respective fields, is able to integrate science and technology, is able to develop teaching materials that are relevant to their needs, situations and conditions, and has certification in certain fields. Thus, professional competence can be summarized as expertise in a field or subject that is taught in terms of mastering the content, materials and methods, as well as being responsible for the profession.

Finally, general competencies such as English proficiency where teachers can provide guidance to students who have difficulty understanding the language, the role as a mentor and become the responsibility of teachers to help students overcome personal, academic and emotional problems as well as the school organizational environment that affects the effectiveness of teaching and learning, including school management and leadership, as well as professional culture practiced among teachers (Azarul Razamin Mat et al., 2023; Choyrul Anwar & Putu Sudira, 2022; Mohammad Hafiz Salleh et al., 2022; Muhammad Amin & Bima Mustaqim, 2021). In addition, these competencies help teachers become more capable, resilient, and knowledgeable in facing future challenges.

In facing the challenges of the Industrial Revolution 4.0 era, Mohamed Ally (2019) stated that the national education system must ensure that pupils are equipped with knowledge and skills in line with the ever-changing technological developments, as well as prepare them for jobs that do not yet exist today. Education in the era of Industrial Revolution 4.0 should be a driver for change, fostering the ability of the younger generation to adapt to change, be creative and be able to think critically when facing challenges in the future. In the meantime, according to a study by Muhammad Amin and Bima Mustaqim (2021); Saba Khan et al., 2022, the problems of lack of mastery on the Internet of Things (IoT), lack of facilities in terms of infrastructure, insufficient understanding of technological skills, lack of information on the development and development of IR 4.0 as well as there is a lack of teachers who can inspire students to face the Industrial Revolution 4.0 have been identified. In fact, imbalances in the professional development of teachers in various fields, lack of adequate support for new teachers, and lack of opportunities to share knowledge and experience among teachers are the major challenges faced by the education system in adopting and implementing the Industrial Revolution 4.0 in learning (Azarul Razamin Mat et al., 2023).

Additionally, a study by Azarul Razamin Mat et al. (2023); Melinda Astuti et al. (2021); Nor Aishah Mat Jam and Saifullizam Puteh (2022); Saba Khan et al. (2022); Van Hong and Do Van Dung (2019) stressed the need to implement professional development programmes such as courses, workshops, ongoing training, more specific and strategic to enhance teacher competitiveness and knowledge.

Conclusion

This systematic review analyzed 14 articles between 2019 and February 2023 that provided information on the competence of teachers to face the challenges of the Industrial Revolution 4.0 era. The findings of this study have implications for educators and policymakers in the field

of education, especially for the implementation of teaching and learning . The findings of this study can fill the gaps in future studies by contributing ideas to the researcher in the selection of the scope to be carried out on the implementation of the RBT subject teaching and learning. Based on the findings, it was found that past studies focused more on quantitative methods than qualitative methods. Therefore, it is suggested that future studies be able to focus on studying more deeply by focusing on qualitative methods as well as the challenges faced by teachers in preparing themselves in the era of Industrial Revolution 4.0.

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