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Teacher readiness in terms of technological skills in facing artificial intelligence in the 21st century education era

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ABSTRACT

Students currently being faced are students who were born in the digital era, they are accustomed to things related to the internet, they are already good at playing the gadgets they have, while there are still teachers who are not very good at using various applications for learning. This study aims to determine the readiness of vocational high school teachers to face artificial intelligence in the era of 21st century education.The type of research used in this study is a descriptive quantitative method. The population is 274 teachers. The number of samples is 73 teachers who are drawn using the proportional random sampling technique. The data collection technique is carried out through primary data in the form of questionnaires filled out by respondents and secondary data in the form of data obtained from the school. The test results show the unpreparedness of teachers in terms of technological skills influenced by critical thinking, problem solving, communication, collaboration and creativity. The conclusion of this study is that there is a positive and significant relationship between critical thinking and problem solving, communication, collaboration and creativity on the readiness of vocational high school teachers in facing artificial intelligence in the 21st Century Education era.

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Introduction

Teachers in the 21st century face major challenges in adapting to the rapid development of artificial intelligence (AI). One of the main challenges is adapting curriculum and teaching methods to AI technology to remain relevant and effective. Not all teachers have sufficient technological skills to utilize AI in learning, so adequate training is needed. In addition, AI also brings ethical issues, especially in terms of plagiarism and academic honesty, because students can use this technology to complete assignments without thinking critically. On the other hand, although AI can help in personalizing learning, teachers must still ensure that students do not become too dependent on technology and continue to develop independent thinking skills. The role of teachers in guiding students' social and emotional development is also becoming more important, considering that AI cannot completely replace human interaction in learning. In addition, data security and student privacy are major concerns because many AI applications collect personal information. The changing role of teachers is also a challenge in itself, where they are no longer just as providers of material, but also as learning facilitators who must be able to manage technology wisely. Therefore, teachers need to continue to learn, innovate, and adapt to AI developments so that they can continue to provide meaningful and relevant education for future generations.

Entering the 21st century, the development of information technology is increasingly rapid, in just seconds information can be received easily. As the world of education develops, a teacher must be able to keep up with the demands of the times. A teacher does not just provide conventional subject matter, but a teacher must be able to use technology as a medium in learning. A teacher must be creative and innovative in designing learning, especially using technology. However, in reality, teachers in Indonesia have not been able to fully utilize technology. There are still many teachers who are not ready for the arrival of this technology. Even though currently, all aspects are using digitalization (Rahayuningsih, Y.S., & Muhtar, 2022). (Perdani, B. U. M., & Andayani, 2021) states that if a teacher masters technology then the teacher is ready to provide learning to students. So, mastery of technology is very important for a teacher. Even though in its implementation teachers will encounter challenges, a teacher inevitably has to be ready to accept all the risks and must still behave professionally (Iswatiningsih, 2021). Likewise (Budiana, I., Tinggi, S., Tarbiyah, I., & Village, 2021) explains that when facing the challenges of the 21st century, a teacher must improve his competence and continue to dig up as much information as possible so that the teacher is always up to date and not out of date. Because teachers are agents of change, teachers must make changes from within themselves, then they can transmit them to students so that students have adequate knowledge and technology. Not only that, teachers must also equip students with character and personality education, because science and technology alone are not enough to face the current challenges of 21st century learning. For this reason, of course a teacher must have a lot of knowledge, be able to think critically, be ready to face all kinds of challenges and of course be required to always be wise in dealing with problems.

The development of technology-based learning has experienced rapid growth in the 21st century. These technological developments encourage various innovations, including the use of artificial intelligence in the learning process. The current learning system has its own characteristics, where educational institutions are expected to focus on developing skills that are relevant to this era. 4C skills are the main focus, involving 1) critical thinking skills, 2) creative and innovative thinking skills, 3) communication skills, and 4) collaboration skills (Zubaidah, 2020). For 21st century learning to be effective, it needs to be based on these four skills. Therefore, learning design must be in accordance with modern developments. Building learning models that are relevant to modern learning contexts is very important to provide adequate learning experiences for students. Apart from that, it is hoped that the models implemented can increase student participation in the learning process (Handayani & Wulandari, 2021).

At the same time, advances in artificial intelligence (AI) are also experiencing significant growth. Artificial intelligence is a simulation of human intelligence applied to certain technologies to think and act like humans in general. Examples of AI applications in everyday life involve virtual assistants, phone cameras, social media, e-commerce, chatbot applications, online games, online transportation applications, and other streaming platforms. In this century, the focus of learning shifts from teachers to students. Teachers must be ready to utilize AI in the learning process that supports student learning outcomes. This means they have to develop a more modern learning model and incorporate 21st century skills. One of them is at the vocational high school level. In this research, the AI studied focuses on the use of AI in preparing and implementing learning.

As a result of observations and direct observations carried out by researchers at all vocational schools in the city of Sungai Banyak, information was obtained that there was an imbalance in the form of a gap between expectations and reality, namely the demands of digitalization for teachers on the abilities of the teachers themselves. Conditions in the field are still very worrying both in terms of quality, professionalism and quantity. The students currently being faced are students who were born in the digital era, they are used to things related to the internet, they are already good at playing the devices they own. Moreover, with the many social media and games that have now penetrated all circles, students have become proficient in using technology themselves. However, there are some teachers who are not able to use technology and information well and wisely. However, there are also teachers who are able to use computer devices but are not yet very adept at using various applications for learning. Of course, in this case, these teachers need to further expand their knowledge, such as frequently taking part in training on the use of digital teaching media or participating in various webinar activities organized by the Ministry of Education and Culture.

In a vocational school in Sungai Penuh, 186 out of 274 teachers (around 68%) have difficulty integrating artificial intelligence (AI) into learning. This difficulty is mainly caused by a lack of training (40%), limited technological infrastructure in schools (35%), and minimal understanding of the use of AI in the teaching process (25%). Meanwhile, a survey of students showed that 78% of them were accustomed to using AI, either to find learning references, complete assignments, or understand difficult material. This difference shows a significant digital divide between teachers and students, where the majority of students adapt to technology faster than educators who still face various obstacles in using it. If this gap is not immediately addressed through training and infrastructure improvements, it is feared that the effectiveness of learning will continue to decline.

In the 21st century, teachers are expected to be able to keep up with increasingly rapid technological developments, so that teachers are not technologically illiterate or left behind with the latest technological developments that can be applied in the world of education. By increasing teachers' technological literacy, they can indirectly provide more interesting and enjoyable learning for students and lead to the achievement of learning objectives as a whole. Meanwhile, the facts in the field are that teachers are not yet fully technologically literate. So technology-related training is needed for teachers, one of which is through training on the use of AI which can support the learning process. The AI that teachers can use is Computer Aided Instruction (CAI), which is a revolution in the field of education based on multimedia technology. It is hoped that CAI can be used as an alternative for developing a more effective and efficient education system with lower costs in the future. AI for the world of education is limited to interactive multimedia. A software can be said to be AI if the software can produce predictions, recommendations or decisions based on statistical reasons.

From this research, which is relevant to research conducted by (Klarisa, L., Setiyanti, A.A., Purnomo, H.D., & Gundo, 2023) it can be concluded that students must be ready, individual readiness in this category: readiness of physical, mental, emotional conditions, needs, knowledge and skills; teacher readiness from their educational background; and readiness of facilities and infrastructure. Thus, AI learning in schools can be implemented, but further development and deepening of curriculum preparation for AI learning is needed. Further research will be carried out by (Rahayu, R., Iskandar, S. & Abidin, 2022). This research shows that modern education is a process of developing and empowering all students' potential to develop better character. Education in Indonesia can use various modern learning innovations. One of them is the application of the Blended Learning (MBL) Model, which is very suitable for overcoming the challenges facing Indonesia in the 21st century and preparing the learning environment to enable 21st century competencies to be implemented. In addition, the global transformation towards digitalization forces learning in schools to follow technological advances. Both educators and students are required to understand digital technology.

(Rahayuningsih, Y.S., & Muhtar, 2022). The research shows that teachers must have digital pedagogy skills so that they can improve their abilities in line with modern learning. It is hoped that a teacher will have the ability to compete in the rapid era of digitalization. Furthermore, (Yusuf, M., Julianingsih, D., & Ramadhani, 2023). The study shows that digital education 5.0, which brings technological innovations that enable broader and more flexible educational provision, improves the quality of education by combining scientific and technological innovations. By using innovative learning strategies and advanced technology, digital education 5.0 creates a better learning environment. interactive, creative and adaptive learning. Challenges in implementing technology must also be overcome so that the full potential of digital education 5.0 can be realized.

As a result of relevant research, it can be concluded that teachers need more modern competencies to maximize the learning process. Teachers must have twenty-first century skills that enable them to encourage and facilitate student learning and creativity, design and develop learning experiences and assessments in the digital era, model how to learn and work in the digital era, and encourage modeling digital society and responsibility. . The research entitled "The Readiness of Sungai Banyak Vocational School Teachers in Facing AI in the 21st Century Education Era" is one technology that can be used to achieve 21st century competency goals. The concept of artificial intelligence (AI) can also be interpreted as a part of computer science that focuses on the development of computers, robots, or applications and programs that can operate intelligently like humans. AI also summarizes scientific and engineering disciplines that attempt to create machines that have intelligence, especially in the context of creating intelligent computer programs or applications (Kristianto, 2020). The term Artificial Intelligence (AI) refers to the ability of machines to imitate or mimic human intelligence; this includes various techniques and methods that enable computers to understand, learn, and make decisions based on data (Susanto, 2020). By utilizing AI in the learning process, it is hoped that it can optimize the achievement of learning goals. Apart from that, through the use of AI, it is hoped that teachers and students can collaborate to produce works that can improve their quality and be useful in the future.

Based on research conducted by (Afista, Y., Priyono, A., & Huda, 2020). The research results show that teachers' readiness in facing the independent learning policy has high readiness in preparing concise lesson plans and low readiness in implementing AKM and character surveys as a substitute for the National Examination in terms of cognitive aspects, physical readiness and psychological readiness. Based on research conducted by (Wote, A.Y., & Sabarua, 2020). The results of the research show that the picture of teacher readiness in carrying out classroom learning at GMIH Lina Ino Elementary School is that the five respondents have met competency from the personality aspect. Meanwhile, aspects of learning equipment and classroom management are still in quite poor condition, including the condition of classrooms which lack adequate facilities to support the implementation of the learning process. The teacher readiness design in creating optimal learning at GMIH Lina Ino Elementary School is by optimizing 2 aspects which include, Learning Tools and Class Management; and supporting factors (classroom conditions), considering that the five respondents had the greatest deficiencies in

the ability to manage the classroom. Apart from that, learning tools are also a weak indicator and an indicator of classroom conditions.

Based on research conducted by (Jamjemah, Tomo, D., Erlina & Hartoyo, 2022). The results of the research show that the implementation of learning at SD Negeri 47 Penanjung Sekadau is ready to implement independent curriculum learning. Teacher readiness is categorized as good. The majority of teachers, 86.7%, already understand the structure of the independent curriculum. Meanwhile, there are several teachers with a total of 13.3% who do not understand the structure of the independent curriculum. And the majority of teachers, as much as 80%, already understand the use of the Merdeka Mengajar Platform. Meanwhile, there are several teachers who do not understand the use of the Merdeka Mengajar Platform. (Jaya, H., Yahya, M., Haryoko, S., Saharudin, Lumu, Sabran, & Fakhri, 2023), students and teachers at SMKN 10 South Sulawesi Province are taught robotics programming design and applications, instructor settings, program creation, and reading lesson modules.

(Rudolf, 2019) explains that the main goal of implementing AI is to create an independent learning system that can provide meaning to data. The ultimate goal of developing AI technology is to be able to fully imitate human behavior and movements, including the ability to solve complex problems and imitate human actions (Sidabutar, H., & Munthe, 2022). (Fitri, 2021) states that AI can be successful using algorithms, which can be symbols or mathematical forms. Relevant algorithms are implemented into computer software to sort, filter and select various pieces of data given to modern AI systems. Learning media can be created and designed in accordance with current technological developments, including collaboration using smartphones or what is known as mobile learning (Khomarudin, A. N., & Efriyanti, 2018) Research (Putri, N. L. P. N. S., Permana, P. T. H., 2020) shows that generation Z's closeness to technology greatly influences all aspects of their lives, including the teaching and learning process. Therefore, the development of technology-based learning media can support teachers in teaching students who are also generation Z.

The artificial intelligence technology used produces benefits that can be obtained from its implementation in the classroom. Another example of the contribution of artificial intelligence technology in learning technology is educational games in English language learning (Yunanto, 2019). The Duolingo application as an educational game is able to teach every child the various languages they choose. Currently, many educational game applications have been developed such as Khan Academy Kids, Quick Brain, Puzzle Kids, Animal Shapes Jigsaw Puzzle as interesting learning media (Yasin, 2021). According to (Dadan, 2019) there are several types of AI, namely: self-awareness, theory of mind, limited memory, reactive machine, ANI, ASI and AGI. Next, the way Artificial Intelligence works is (McCarthy, 2019), namely by collecting data, processing information, machine learning and decision making. The aim of creating AI is to create an expert system and implement human intelligence into machine (Khusna, S., Dalil Rohman, A., Musa, M. M., Rini, J., & Pekalongan, 2022). The applied field of AI consists of expert systems, NLP, CVR, CAI, ASR and Robotics (Masturoh & Anggita, 2019).

The word "ready" comes from the prefix to- and the suffix -an. Readiness, as explained in the Big Indonesian Dictionary, refers to the state of being prepared to prepare something. The English perspective describes the concept of "readiness" as preparedness, defined as the ability to engage in an activity, as well as having the desire, desire, or drive to do so. Overall, readiness includes a person's condition which makes him ready to provide a certain response or response to a situation (Slameto, 2020). The learning pillars of the Industrial Revolution 4.0 are known as 4C, which stands for creativity, critical thinking, collaboration and communication. These four elements are an important foundation in the modern curriculum and are essential for students who want to achieve success in the contemporary world. The 4Cs help increase students' levels of creativity and critical thinking abilities, providing the necessary preparation to face today's challenges. The 4C concept has been integrated into the education system, such as the Merdeka Curriculum, which is designed to facilitate the adaptation of teachers and students to learning standards. The future of education requires that teachers not only adapt, but also think creatively in designing teaching that suits students' needs and abilities. The goal is so that students can learn independently and be more active in understanding the material. Apart from implementing the 4Cs, as explained in the first paragraph, there are two additional skills that are the focus for students and teachers, namely character and citizenship. This improvement emerged from a shift in the teaching paradigm which was previously teacher-centered, now shifting to student-centered, as is done by the Merdeka Curriculum which prioritizes student character development.

Capacity, (Dalyono, 2020) explains, includes a person's ability in terms of physical, mental and learning abilities. Physical readiness involves sufficient energy and good health, while mental readiness includes adequate interest and incentive to undertake an activity. (Hersey & Blanchard, 2021) explain that the concept of maturity consists of two aspects, namely job maturity (ability) and psychological maturity (willingness). Teacher readiness can be seen from several aspects such as knowledge, skills and professional competence (Sukardjo, M., Nirmala,

B., Ruiyat, S. A., Annuar, H., & Khasanah5, 2023) A 21st century teacher must have the 4C abilities, namely creativity, critical thinking, communication and collaboration (Sudarisman, 2019) The free learning curriculum currently appears as a form of action taken in facing difficulties and is the beginning of educational progress (Syaripudin, S., Witarsa, R., & Masrul, 2023)

Method

This study uses a quantitative method and is included in the descriptive research type. A quantitative approach is more suitable for this study because this study requires proof of temporary assumptions/hypotheses that can be done through a quantitative approach. In this method, researchers use research instruments to collect data and analyze them quantitatively or statistically, with the aim of testing the formulated hypothesis (Sugiyono, 2021). Meanwhile, descriptive research is an approach that provides a detailed explanation of the subject or object being studied (Sugiyono, 2021). (Sudjana, 2020) said that this method is generally used to solve or answer a problem through data collection, analysis, classification, inference and report preparation. The purpose of this study was to determine the level of readiness of vocational high school teachers in facing the era of artificial intelligence in the context of modern education. This research was conducted at a vocational high school in Sungai Banyak City, Jambi. This research will be conducted in the even semester of the 2023/2024 academic year. The population used in this study were all teachers at vocational high schools in Sungai Banyak consisting of 5 vocational high schools with a total of 274 teachers. The number of samples used in this study was 73 teachers who were taken randomly proportionally from the existing population. Sampling was carried out using the Taro Yamane formula to draw samples using proportional random sampling. Data collected from teachers had received approval from the principal.

Furthermore, for instrument testing, a sample of 30 respondents was used from the existing population and these respondents were not selected as research samples, so they could be used for instrument testing. The data collection techniques used were primary data and secondary data. The research instrument used was a questionnaire that had been tested for validity and reliability. The data analysis technique used was multiple linear regression. There were several tests carried out, namely the analysis prerequisite test in the form of normality, multicollinearity, and heteroscedasticity tests. Furthermore, the hypothesis test consisted of simple correlation analysis, significance test, multiple correlation analysis, F test and coefficient of determination. Data processing was carried out with the help of IBM SPSS 26 and Microsoft Excel applications.

This study has several limitations. First, the main focus is only on teacher readiness in technology skills without considering other factors such as institutional attitudes or policies. Second, the descriptive quantitative method used only describes the phenomenon without analyzing the cause and effect relationship. In addition, the research sample is limited to a particular region or institution, so the results cannot be generalized widely. Research instruments such as questionnaires also have limitations in capturing the real skills of teachers. The rapid development of AI can make the results of this study less relevant in a short time. Finally, this study did not evaluate the effectiveness of AI implementation in learning, so it only focused on teachers' technological readiness without assessing the impact of its implementation.

Results and Discussions

In the data description section, the teacher's readiness to face artificial intelligence in the 21st century education era is described in detail. In this study, the objects of research were vocational school teachers in the city of Sungai Banyak. After carrying out proportional random sampling, a sample of 73 teachers was obtained. All research data that is entered and meets the requirements is processed and analyzed to reveal information in accordance with the research objectives. Briefly it can be stated that the description of the research data for variables X1, X2, X3, X4 and Y can be seen in table 1.

Table 1. Variable Respondent Data (X_1), (X_2), (X_3), (X_4) dan (Y)

Statistics						
		X1	X2	X3	X4	Y
N	Valid	73	73	73	73	73
	Missing	0	0	0	0	0
Mean		109.5616	112.8356	106.5342	108.5753	124.8904
Median		109.0000	112.0000	106.0000	108.0000	125.0000
Mode		109.00	112.00	106.00	108.00	125.00
Std. Deviation		11.95360	12.44099	11.88496	11.98948	14.17016
Variance		142.889	154.778	141.252	143.748	200.793
Range		56.00	58.00	54.00	57.00	64.00
Minimum		84.00	87.00	81.00	83.00	96.00
Maximum		140.00	145.00	135.00	140.00	160.00
Sum		7998.00	8237.00	7777.00	7926.00	9117.00

(Source: Independent Data Processing, 2024)

Hypothesis testing is carried out using simple correlation analysis, significance test, multiple correlation analysis, F test and coefficient of determination, namely:

Hypothesis Testing

Hypothesis testing for this research can be calculated using simple correlation analysis, significance test, multiple correlation analysis, f test and contribution coefficient as follows:

Simple Correlation Analysis

Simple correlation analysis was carried out to determine the relationship between each variable partially/separately. Search for simple correlation analysis using the IBM SPSS 26 application. For more details, see table 2:

Table 2. Simple Correlation Analysis

Correlations						
		X1	X2	X3	X4	Y
X1	Pearson Correlation	1	.474**	.367**	.568**	.473**
	Sig. (2-tailed)		.000	.001	.000	.000
	N	73	73	73	73	73
X2	Pearson Correlation	.474**	1	.741**	.786**	.843**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	73	73	73	73	73
X3	Pearson Correlation	.367**	.741**	1	.693**	.894**
	Sig. (2-tailed)	.001	.000		.000	.000
	N	73	73	73	73	73
X4	Pearson Correlation	.568**	.786**	.693**	1	.799**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	73	73	73	73	73
Y	Pearson Correlation	.473**	.843**	.894**	.799**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	73	73	73	73	73

(Source: Independent Data Processing, 2024)

Based on this table, it can be seen that the relationship between the variables critical thinking and problem solving (X1) and communication (X2) has a significance value of 0.000<0.05, which means there is a significant correlation. Furthermore, between critical thinking and problem solving (X1) and collaboration (X3) has a significance value of 0.001<0.05, which means there is a significant correlation. Then, between critical thinking and problem solving (X1) and creativity (X4) has a significance value of 0.000<0.05, which means there is a significant correlation.

Then, between critical thinking and problem solving (X1) and teacher readiness to face AI (Y) has a significance value of 0.000<0.05, which means there is a significant correlation. Furthermore, the correlation between X2 and X3 is 0.000<0.05, which means there is a significant correlation. Furthermore, the correlation between X2 and Y has a significance of 0.000<0.05, which means there is a significant correlation. Then the correlation between X3 and Y has a significance of 0.000<0.05, which means there is a significant correlation.

Furthermore, the correlation between X4 and Y has a significance of 0.000<0.05, which means there is a significant correlation.

Significance Test

According to (Riduwan, 2021), to test the significance between one independent variable and one dependent variable, it is done using the t test formula. From the results of the t test, the calculated t value is obtained and then compared with the t table. Calculation of t table with = 0.05. The criteria for this test are if t count > t table at a significance level of 0.05 then the hypothesis is accepted. And conversely, if t count < t table, then the hypothesis is rejected. For more details, see table 3:

Table 3. Significance Test

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-8.547	6.448		-1.325	.189
	X1	.046	.059	.039	.778	.439
	X2	.316	.084	.277	3.758	.000
	X3	.658	.075	.552	8.734	.000
	X4	.208	.087	.176	2.394	.019

(Source: Independent Data Processing, 2024)

Based on table 3, it can be seen that the tcount value for variable Furthermore, the tcount value for the variable Then the tcount value for variable Furthermore, the tcount value for variable

Multiple Correlation Analysis

Multiple correlation analysis is used to look for correlations between four or more independent variables (X) together with the dependent variable (Y). The results of the multiple correlation analysis can be seen in table 4:

Table 4. Multiple Correlation Analysis

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.942[a]	.887	.880	4.91049

(Source: Independent Data Processing, 2024)

Based on table 4, it can be seen that the multiple correlation value for the variables of critical thinking and problem solving, communication, collaboration and creativity together on teacher readiness in facing AI is 0.942. Because rcount>rtable (0.942>0.2302) is at a significance level of 0.05, it can be concluded that the fifth hypothesis in this study is accepted, namely that there is a positive and significant relationship between critical thinking and problem solving, communication, collaboration and creativity on teacher readiness. in dealing with AI

F Test

According to (Riduwan, 2021), to find out the significance of multiple correlation, first look for Fcount and then compare it with Ftable. If Fcount > Ftable then the data is significant at α=0.05 with degrees of freedom dk=n-k-1, conversely if Fcount < Ftable then the fifth hypothesis is rejected. For more details, see table 5:

Table 5. F test

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12817.446	4	3204.362	132.890	.000[b]
	Residual	1639.677	68	24.113		
	Total	14457.123	72			

(Source: Independent Data Processing, 2024)

Based on table 5, it can be seen that the value of fcount>ftable (132.890>2.50) with a significance of 0.000<0.05. So it can be concluded that the fifth hypothesis in this research is accepted, namely that there is a positive and significant relationship between critical thinking and problem solving, communication, collaboration and creativity on teacher readiness in dealing with AI.

Coefficient of Determination

Based on tests carried out using IBM SPSS 26, the coefficient of determination of critical thinking and problem solving on teachers' readiness to face AI was 0.213 or 21.3%. Furthermore, the coefficient of determination of communication on teacher readiness to face AI is 0.707 or 70.7%. Then it was obtained that the coefficient of determination of collaboration on teacher readiness to face AI was 0.796 or 79.6%. Furthermore, the coefficient of determination of critical thinking and problem solving, communication, collaboration and creativity on teacher readiness to face AI was 0.880 or 88%.

In this discussion section, the results of research regarding the readiness of vocational school teachers to face artificial intelligence in the era of 21st Century Education will be explained. In this section, a description of each variable will be discussed. Critical thinking and problem solving is a process in which information is analyzed and appropriate decisions are made. This process involves elements of creative thinking, asking questions, and considering various points of view. The use of this concept can be applied to overcome students' difficulties in capturing or understanding learning material. First of all, it is recommended to create a well-structured learning system. Second, apply a two-way learning approach by asking questions or holding discussions after learning. This approach can increase students' curiosity and stimulate their interest in the learning process.

Furthermore, communication is the ability to communicate involving skills to convey information concisely and easily understood to other people. It includes various forms of communication, such as oral, written, and digital. Applying this idea can be done by choosing a topic to discuss, then initiating the discussion by asking interesting questions. Previously, communication could be done via text messages or through reading or watching videos. Students will be asked to summarize the activity after they read or watch. The third independent variable is collaboration. Where collaboration is the ability to work together with other people to achieve common goals, involving sharing resources and using teamwork skills. With the 4C approach, a shift in focus occurs from simply memorizing information to actively engaging in problem solving and acquiring skills that are relevant to real life. Furthermore, creativity is the ability to be innovative and imaginative. This involves utilizing new inspiring resources and adopting the latest technology. By having creative skills, both students and educators can combine innovation with technological developments. There are various examples of how applying creative thinking concepts can make the learning process more interesting and meaningful for students.

The dependent variable used in this research is the readiness of vocational school teachers to face AI in the era of 21st Century Education. Where teacher readiness is an attitude that shows a willingness to respond or respond to the application of technology, and is an important control tool so that educational aspects achieve learning goals. In the era of globalization, teachers have changed their roles from educators and teachers to facilitators for students. As a facilitator, teachers actually have a greater responsibility towards students. Where in learning there are many learning resources that students can use to gain knowledge, starting from the internet, e-learning, e-modules and various other learning sources. In the future, critical thinking and solving problems for teachers will be needed, because by changing the role of teacher as facilitator, teachers must be able to think critically in solving problems in learning.

Apart from that, teachers must improve two-way communication skills with students, in order to achieve learning goals. Furthermore, teachers must also improve their collaboration skills, because with increasingly rapid technological developments, teachers are required to be able to collaborate with students in making learning enjoyable. Then, teachers must also improve their ability to carry out learning creatively, so that learning is more interesting for students. Based on the coefficient of determination for critical thinking and problem solving, communication, collaboration and creativity, the teacher's readiness to face AI is 0.880 or 88%. This means that the independent variable has an influence of 88% on the dependent variable and the remainder is influenced by other factors outside those studied. Based on the significance test, it can be seen that the tcount value for variable Furthermore, the tcount value for the variable Then the tcount value for variable Furthermore, the tcount value for variable

Based on multiple correlation testing, it can be seen that the multiple correlation value for the variables of critical thinking and problem solving, communication, collaboration and creativity together on teacher readiness in facing AI is 0.942. Because rcount>rtable (0.942>0.2302) is at a significance level of 0.05, it can be concluded that the fifth hypothesis in this study is accepted, namely that there is a positive and significant relationship between critical thinking and problem solving, communication, collaboration and creativity on teacher readiness. in dealing with AI. Based on the F test, it can be seen that the value of fcount>ftable (132.890>2.50) with a significance of 0.000<0.05. So it can be concluded that the fifth hypothesis in this research is accepted, namely that there is a positive and significant relationship between critical thinking and problem solving, communication, collaboration and creativity on teacher readiness in dealing with AI.

Conclusions

This study examines teachers' readiness in technological skills to face artificial intelligence (AI) in the 21st century education era. The results show that the level of teacher readiness varies, with some teachers already having a good understanding of technology, while others still face challenges in mastering relevant AI skills for learning. Factors such as access to training, teaching experience, and institutional support play a role in their readiness. However, this study has limitations, such as limited sample coverage and a descriptive quantitative approach that does not explore causal factors in depth. Therefore, further research is recommended to examine the variation in teacher readiness based on educational background, teaching experience, and strategies that can improve their technological competence in facing the development of AI in education.

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