



The Teacher's Challenge in 21st Century: Physics and Science Teachers' ICT Competencies in Learning Process

Elisa¹, Fitria Herliana^{1*}, Ahmad Farhan¹, Syamsul Rizal²

¹Department of Physics Education, Universitas Syiah Kuala, Banda Aceh, Indonesia.

²Department of Physics Education, Universitas Serambi Mekkah, Banda Aceh, Indonesia.

Received: September 18, 2023

Revised: October 29, 2023

Accepted: November 25, 2023

Published: November 30, 2023

Corresponding Author:

Fitria Herliana

fitriaherliana@unsyiah.ac.id

DOI: [10.29303/jppipa.v9i11.5384](https://doi.org/10.29303/jppipa.v9i11.5384)

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Abstract: This study aims to determine the competence of Information and Communication Technology (ICT) of science and physics teachers in Aceh Tamiang District in the learning process. The survey method was used in this study and data to measure teachers' ICT competencies were obtained with a questionnaire instrument. The questionnaire were developed from ICT competences indicators as many as 19 items. The respondents were 40 science and physics teachers in Aceh Tamiang. Data were analyzed using quantitative descriptive analysis and correlation test. Based on the perceptions obtained from the research questionnaire data, the teachers' ICT competence is very high category. In terms of employment status, the average ICT competence of non-civil servant teachers is higher than civil servant teachers. Likewise, from the review of tenure, teachers who have <5 years of service have higher ICT competencies compared to teachers who have 6-15 years and >15 years of service. The correlation test results obtained a weak relationship between employment status and tenure of science and physics teachers in Aceh Tamiang on ICT competence. These results can be a concern for civil servant teachers and teachers who have a longer tenure can further improve ICT competencies in learning to produce quality graduates.

Keywords: ICT Competencies; Learning process; Teacher physics

Introduction

Education is the main element in the process of developing a person to be better. In education, there is a teaching and learning process that is at the core of every education system in schools, so it is necessary to pay attention to the process of teaching and learning activities (Chai et al., 2017). The process carried out in schools cannot be separated from the role of teachers and students in it. Teachers have an important role to guide, direct and motivate students to be able to achieve maximum results (Farhan, Herliana, et al., 2021). Likewise, with students, students have a role that is no less important. Students play the role of students who study hard so that they can develop their abilities in thinking, reasoning, communicating, and solving problems based on the learning process they have done (Soewarno et al., 2020).

In line with the development of the 21st-century education paradigm, education in Indonesia is faced with the challenge of producing human resources with superior competencies that can compete globally in the future. Competencies that are expected to be possessed by human resources are more focused on thinking and communication competencies. Thinking competence means that human resources are expected to have broad knowledge, critical thinking skills, and creative thinking skills. Communication competence means that human resources should have the ability to communicate to work together and convey critical creative ideas (Abidin, 2014). Along with the rapid development of the era of communication competence, this leads to the competence of information and communication technology (ICT). Teachers and students are required not only to be able to communicate but also to communicate and convey information using technology (He et al., 2021). This competency is needed in the

How to Cite:

Elisa, E., Herliana, F., Farhan, A. ., & Rizal, S. (2023). The Teacher's Challenge in 21st Century: Physics and Science Teachers' ICT Competencies in Learning Process. *Jurnal Penelitian Pendidikan IPA*, 9(11), 9113-9119. <https://doi.org/10.29303/jppipa.v9i11.5384>

learning process, one of which is in physics. Physics is one of the subjects in the science family that can develop analytical, inductive, and deductive thinking skills in solving problems related to natural events, both qualitatively and quantitatively by using mathematics, and can develop knowledge, skills, and self-confidence. (Anggistia et al., 2019). In this regard, thinking and communication competencies are needed in physics learning to achieve the success of the learning process.

Efforts are needed to face the challenges of 21st-century education, namely printing human resources who have ICT competencies, so teachers who have these competencies are needed so that the learning process runs according to the demands of the times (Egan et al., 2017). However, in reality, during the COVID-19 pandemic, where all education relied on ICT, there were many complaints from teachers and students, especially in rural areas (Ihwanah, 2020; Lockee, 2021; Mondol et al., 2020; Nagaj et al., 2021; Onyema et al., 2020). Various factors of difficulty in implementing the learning process occur, including signal difficulties, the lack of ICT tools for learning, to the low skills of teachers and students using ICT in learning (Herliana et al., 2020; Rahiem, 2020; Schneider et al., 2021). This shows the low ICT competence of teachers and students in rural areas. Therefore, studies related to ICT competencies that teachers currently have, especially physics subjects are needed to find out how ready our country is to produce human resources who can compete in the era of 21st-century education with their ICT competencies. This study can be used as a basic reference for the government and practitioners to improve the ICT competence of teachers to be able to produce the next generation who have ICT competence, which is one of the important competencies in the 21st century.

Method

The study used a quantitative approach, survey methods, and descriptive analysis. The target population is all science and physics teachers in Aceh province. The sample was taken using the purposive sampling technique and obtained by 40 teachers of physics and science in the SMP/SMA Aceh Tamiang district. The data collection instrument used a Likert scale questionnaire with 4 points totaling 19 items to measure the competence of technology, information, and teacher communication in learning. The instrument used is an instrument developed by Tondeur et al. (2017) and has been valid. The research activity was carried out by observing the ICT skills of teachers in workshops on the use of ICT in learning which was carried out in the Aceh Tamiang district. Furthermore, interviews were conducted related to the learning system used by teachers so far, whether they have used ICT or not, and

how deep the role of ICT in the learning process has been carried out by the teacher. Data collection was strengthened by distributing questionnaires to all physics teachers in Aceh Tamiang district to measure the ICT competencies possessed by teachers in Aceh Tamiang district. Data analysis used descriptive statistics to obtain information on the percentage of technology, information, and communication competencies possessed by teachers in Aceh Tamiang District.

Data analysis used descriptive statistics to obtain information on the percentage of technology, information, and communication competencies possessed by teachers in Aceh Tamiang District using the equation:

$$p = \frac{\text{Total score of each item}}{\text{Maximal score}} \times 100\% \tag{1}$$

Furthermore, a recapitulation of the percentage of respondents' answers from a questionnaire that measures ICT competence is carried out. Then the average percentage results are compared with the interpretation criteria of the teacher's ICT competency score results to find out the measurable percentage result categories by referring to the following criteria table:

Table 1. Table of Interpretation of Teachers' ICT Competency Scores

Score	Criteria
86-100	Very high
76-85	High
60-75	Moderate
55-59	Low
≤54	Very Low

Furthermore, to find out the correlation between the ICT competencies of teachers with their employment status and length of service, they were analyzed using a correlation test.

Result and Discussion

The implementation of this research was carried out in Aceh Tamiang Regency by distributing questionnaires that measured the Information and Communication Technology (ICT) competence of Physics and Science teachers after attending training on the use of ICT in Physics Science learning which was mentored by a lecturer from the Department of Physics Education, FKIP - USK. The results of the responses from science and physics teachers to their ICT competencies can be seen in the graph below:

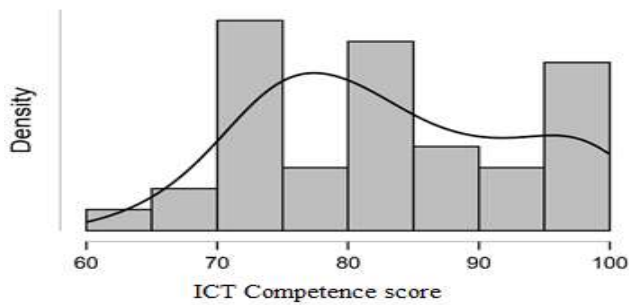


Figure 1. Distribution of ICT competency score data for science and physics teachers in Aceh Tamiang District

The graph above shows the ICT competency scores of science and physics teachers in Aceh Tamiang spread evenly from 60 to 100. The average score is 83.3 which is classified as having high competence, although there are still some teachers who have an ICT competency score of 64.4 is moderate competence. ICT competence greatly affects the quality of learning in the classroom (Lawrence et al., 2018), with the high ICT competence of teachers, the learning process takes place effectively in this 21st-century learning era (Liesa-Orús et al., 2020). In learning in the 21st century, ICT competence has an important role in achieving the success of a learning process (Chen et al., 2017) because the entire learning process has used technology, both from learning planning, the learning process, to evaluating the learning process (Nikolić et al., 2019). The ICT competence of science and physics teachers in Aceh Tamiang Regency, which is relatively high, shows that the 21st-century learning process has been running, although there are still 32.5% of teachers who have sufficient ICT competence as illustrated in the following graph:

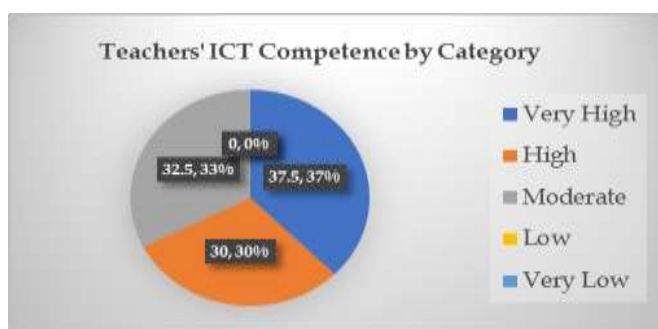


Figure 2. Percentage of teachers' ICT competence by category

This shows that only about 63% of teachers have high ICT competence, so most have been able to carry out the learning process to the demands of learning in the 21st century. However, there are still 32.5% who need attention in efforts to improve ICT competence so that the learning process in the 21st century can run optimally and produce quality that can compete globally (Batanero et al., 2019).

Teachers' ICT competence can be measured by 2 indicators, namely (1) teachers can use ICT to facilitate student learning competencies using ICT and (2) teachers can manage ICT for their teaching purposes (Tondeur et al., 2017). The ICT competence of science and physics teachers in Aceh Tamiang Regency based on the above indicators can be seen in the following table:

Table 2. Descriptive Statistics of ICT Competence of Teachers Based on Their Indicators

	Ability to use ICT to facilitate student learning competence using ICT	Ability to manage ICT for their teaching purposes
Valid	40	40
Missing	0	0
Mean	85.17	880.859
Median	86.364	75
Mode	75	75
Std. Deviation	9.67	11.26
Variance	93.502	126.797
Range	29.554	43.75
Minimum	70.455	56.25
Maximum	100	100
Sum	3406.818	3234.375

The data above shows that science and physics teachers in Aceh Tamiang District have high competence for each indicator, but the ability to manage ICT for their teaching purposes has a lower score than the ability to use ICT to facilitate student learning competence using ICT. This shows that science and physics teachers in Aceh Tamiang District have been able to use ICT and involve students directly in the learning process using ICT. However, in designing learning, carrying out the learning process, to evaluate ICT-based learning, has not been completely done because preparing all appropriate learning tools for teaching purposes is more difficult than using learning tools that are already available (Herliana et al., 2020). Of the 40 science and physics teachers in Aceh Tamiang District, still, 53% of teachers can manage ICT in learning with sufficient and low categories as can be seen in the following figure:

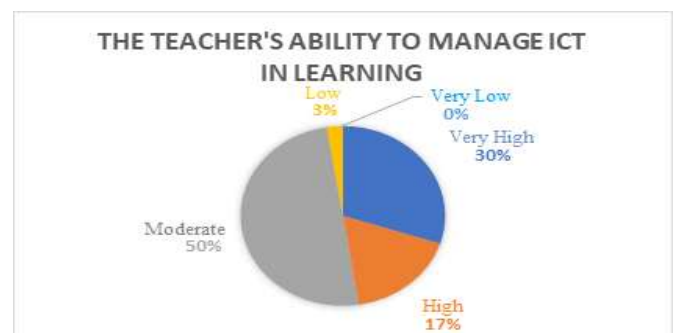


Figure 3. Percentage of teachers' ability to manage ICT in learning

This shows that the ICT management by teachers is still not optimal to achieve their own teaching goals. The lack of teacher skills in developing ICT-based learning tools can be one factor in the lower ability to manage ICT in learning (Kaur, 2023; Muslem et al., 2018). In managing to learn to achieve our own teaching goals, we need the skills to design learning according to the goals to be achieved, the skills to manage the classroom using all the tools that have been prepared, and evaluate the learning (Farhan, Wahyuni, et al., 2021). Therefore, it is still very necessary to develop teacher ICT competencies in terms of ICT management in learning so that teachers can prepare all the needs needed for the learning process according to their respective teaching goals.

Employment status is a situation that distinguishes one employee from another in an agency (Hendrajana et al., 2017) which can affect various aspects of the field of work. Including ICT competencies possessed by teachers with different employment statuses, namely civil servant and non-civil servant. In terms of employment status, the response results show that the ICT competence of non-civil servant teachers is higher than that of civil servant teachers, which is 85.9 while civil servant teachers are 81.7 as shown in the graph below:

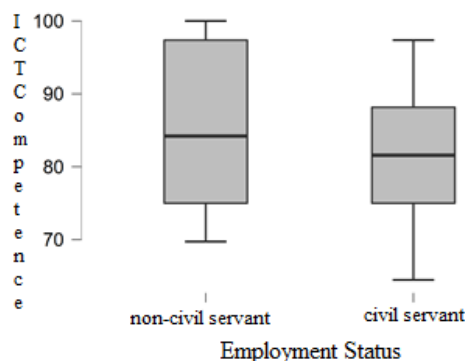


Figure 4. The average teachers' ICT competence score in terms of employment status

Although both of them are classified as having high ICT competence, the results showing that the ICT competence of non-civil servant teachers is higher than that of civil servant teachers are interesting to discuss considering that non-civil servant teachers are non-permanent teachers while civil servant teachers are permanent teachers who have been selected through the various tough and competitive test. ICT competence requires motivation both from oneself (internally) and externally to want to develop it and use it in the learning process (Zamir, 2019). If there is no motivation, then the learning process carried out will return to using conventional approaches so that 21st-century learning will not be realized (Guillén-Gómez et al., 2019). Non-

civil servant teachers in Aceh Tamiang District have greater demands because they are supervised by their direct supervisor at the school, namely the principal (Masinambow et al., 2017), so there is an external motivation that encourages teachers to continue to develop their competencies for the sake of realizing 21st-century learning in the school environment, one of which is ICT competence.

In addition, when viewed from the length of the teacher's tenure, the results of the ICT competence of science and physics teachers in Aceh Tamiang District are the highest for teachers with <5 years of service, i.e. 87 and the lowest are teachers with >15 years of service, i.e. 81,4, as can be seen in the graph below:

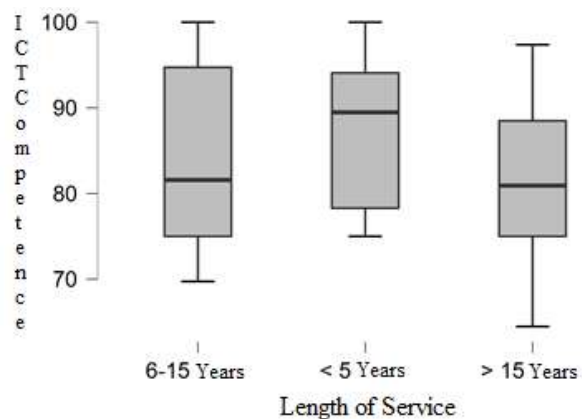


Figure 5. The average teachers' ICT competence score in terms of length of service

This shows that fresh graduate teachers with <5 years of service are superior to other teachers. The experience that teachers get while sitting in college can be a very influential factor in their ICT competence (Zweekhorst et al., 2015). Considering these fresh graduate teachers have more learning experience using ICT compared to teachers who have long left college (Herliana et al., 2021) even though teaching experience using ICT is still relatively minimal (Raman et al., 2014). However, the current number of ICT-based training that is followed by old teachers makes teachers able to adapt to the times (Elisa et al., 2021; Esfijani et al., 2020). All types of training related to learning in the 21st century need to be done to continue to update the competence of teachers, especially teachers who have had a working period of > 15 years to produce students who have 21st-century competencies and can compete globally.

Seeing the differences in teachers' ICT competency scores based on staffing status and length of service, then a correlation test was carried out to find out whether there was a relationship between teachers' ICT competencies and their employment status and whether there was a relationship between teachers' ICT

competencies and the length of their tenure. The results of the data analysis can be seen in the following table:

Table 3. Test the Correlation between Teachers' ICT Competence with Employment Status and Length of Service

		Spearman		Kendall	
		rho	p	Tau B	p
Employment status	ICT competence	0.164	0.312	0.139	0.305
ICT competence	Length of service	0.175	0.279	0.138	0.285

The data shows that there is no significant correlation between the ICT competence of teachers and their employment status and the teacher length of service. Teachers who have civil servant and non-civil servant status have high ICT competence, as well as teachers who work <5 years, 6-15 years, and >15 years. There is only a slight difference in scores between each category so no significant relationship is found between variables. This means that both civil servant and non-civil servant teachers develop their ICT competencies to realize 21st century learning in SMP and SMA Aceh Tamiang District. Likewise with teachers who have a working period of <5 years, 6-15 years, and >15 years. Teachers who work for <5 years already have ICT competencies from college (Zweekhorst et al., 2015), while teachers who work for > 15 years have a lot of experience teaching in class and participate in teacher training activities to develop their competence in teaching (Elisa et al., 2021; Esfijani et al., 2020). Teachers who work for 6-15 years have provisions from college and have sufficient teaching experience and participate in all kinds of training organized by various parties. Based on the description above, each teacher with a long working period has provisions from different sources to develop their ICT competencies, so that each teacher's ICT competence can develop according to the demands of 21st-century learning.

Conclusion

Science (Physics) teachers in Aceh Tamiang District Junior and Senior High Schools have high Information and Communication Technology (ICT) competencies. Teachers have been able to use ICT in the learning process in the classroom and involve students using ICT in the learning process. However, the ability to manage the use of ICT appropriately in learning shows the lowest score compared to the other two indicators. If viewed from the employment status of a civil servant and non-civil servant, non-civil servant teachers have higher ICT competence than civil servant teachers. Meanwhile, when viewed from the length of

service, teachers who have a working period of < 5 years have the highest ICT competence compared to teachers who have a working period of 6-15 years and > 15 years. However, the results of the correlation test, employment status, and length of service do not have a significant relationship with the ICT competence of teachers. The results of this study can be used as basic information about the ICT competencies of science and physics teachers in Aceh Tamiang District for the government, education practitioners, and related parties to continue to improve the ICT competencies of teachers in rural areas so that they are not left behind with human resources in cities for progress and the rapid development of the times.

Acknowledgments

Thank you to all those who have helped both morally and materially to the completion of the research and writing of this article. Hopefully, the results of this research can be useful for the development of education in Indonesia, especially in Aceh Province.

Author Contributions

All authors contributed to the completion of this paper

Funding

This research received no external funding.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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