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Chemistry Teachers' Self-efficacy for Using Information and Communication Technology: A Survey Cross Sectional

Insani Efrili Yanti[1*], Hari Sutrisno[1]

[1]Department of Chemistry Education, Faculty of Mathematics and Natural Science, Yogyakarta State University, Indonesia.

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Corresponding Author:
Insani Efrili Yanti
insaniefrili14@gmail.com

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Abstract: The utilization of ICT in education could be further optimized due to the low self-efficacy of teachers. Teachers' years of teaching experience and the status of their schools have an influence on their ICT self-efficacy. This study aims to describe the differences in ICT self-efficacy among chemistry teachers based on their teaching experience and school status. This study used a quantitative approach with a cross-sectional survey method. The research was conducted in 31 high schools in Pekanbaru City and included a randomly selected sample of 50 chemistry teachers. The research instruments consisted of ICT self-efficacy questionnaires 14 items. ICT self-efficacy instrument declared valid and reliable using the Rasch model test. Additionally, interview data were employed to reinforce the findings from the questionnaire. The research questionnaire data underwent processing using analysis descriptive statistics and a two-way ANOVA test with SPSS. The results of the research show that there is a significant difference in the ICT self-efficacy of chemistry teachers based on the teacher's teaching experience with significance level of 0.005 and there is no difference the ICT self-efficacy of chemistry teachers based on school status with significance level of 0.783. The effect size test shows that the partial eta square value for the effect of teaching experience belongs to the high category while school status belongs to the low category.

Keywords: Chemistry teacher; ICT self-efficacy; school status; teaching experience

Introduction

The rapid development of information and communication technology (ICT) in the 21st century affects all aspects of people's lives, including education (Krause et al., 2017). The current educational context focuses on innovation and the maximum use of information, the internet, and technology (Oktavian & Aldya, 2020). Technology is needed to improve the quality of learning (Ghavifekr & Rosdy, 2015). Technology plays a vital role in the world of education. A real example of the importance of technology can be seen during the COVID-19 pandemic in 2020; the education system changed, where initially face-to-face learning in class was switched to online learning (Purnasari & Sadewo, 2021). Apart from that, technology is also needed to improve the quality of education. For example, chemistry teachers use technology to create chemical structures, animate molecular shapes, and illustrate representation rubrics (Hoai et al., 2023). With this technology, chemical materials consisting of abstract concepts can be represented more realistically through animated visualization (Mashami & Khaeruman, 2020). However, many schools still need to be optimal in utilizing and integrating technology in their teaching and learning processes (Azhari & Fajri, 2022). This is due to low teacher awareness regarding the importance of information and communication technology in learning (Hidayat et al., 2016).

The integration of ICT in chemistry learning in the modern era is now a necessity because chemistry subjects are not only taught to students with literacy

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(reading, writing, and calculations), but there needs to be a new form of literacy, namely data and technology literacy in order to improve learning (Dewi et al., 2019). Technology-integrated learning certainly needs to be supported by various educational elements, especially teachers. Teachers from various disciplinary backgrounds must be able to design and develop learning processes with technology-based approaches that can encourage student learning success. According to research results Maatuk et al. (2022), applying information technology in teaching and learning activities can significantly increase student learning motivation. Nasution (2018) explains the benefits of technology in the learning process, namely, 1) for students, it increases attention, concentration, motivation, and independence; 2) for teachers, it can reduce the use of time for delivering material, making students' learning experience more enjoyable, designing material more interesting, and encourage teachers to increase their knowledge and skills about computers.

Teachers are the primary key to the success of ICT integration in learning (Liesa-Orús et al., 2020). Teachers must continually develop according to current developments, including ICT developments in education (Adisel & Prananosa, 2020). Law Number 14 of 2005 concerning Teachers and Lecturers stated that teachers are obliged to improve and develop academic qualifications and competencies on an ongoing basis in line with developments in science, technology, and arts (BPK, 2005). However, in reality, there are still many teachers who are still technologically illiterate due to ignorance of current technological advances (Syahid et al., 2022). Most teachers have inadequate competence and skills in designing and implementing learning using technology constructively. A survey conducted by the Ministry of Education and Culture in 2018 showed that only 40% of non-ICT teachers were ready with technology, meaning that 60% of teachers were still not ready with technology (Kemendikbud, 2018).

Integration of ICT in learning can be carried out if teachers have the skills to use media and communication technology; therefore, teachers need to have good ICT skills to integrate ICT into learning. The effectiveness and success of integrating information and communication technology in learning also depend on the teacher's readiness to use technological tools, namely self-efficacy in using technology (Hatlevik & Hatlevik, 2018). ICT self-efficacy describes self-confidence beliefs about the effective use of computers (Hong et al., 2014). In this context, teacher self-efficacy to successfully use technology in teaching practice is very important because it strongly influences behavior when teaching, in what way, to what extent, and how successful teachers use technology for instructional purposes (Šabić et al., 2022).

Self-efficacy is a prominent concept in the integration of technology in education. Experts argue that teachers' self-efficacy regarding the use of technology will influence individuals' confidence in their teaching abilities (Dursun, 2019). Teachers who can integrate software and technological devices are said to have good ICT self-efficacy (Atabek, 2020). The research results of Mlambo et al. (2020) show that teacher self-efficacy still needs to improve in using ICT in learning activities, which limits the use of ICT in learning activities and makes it less than optimal. Based on relevant literature, students tend to avoid using technology in learning because teachers' computer competency needs to improve (Durak, 2021). In this case, Kim et al. (2013) emphasized that teachers cannot integrate technology into the learning process when they demonstrate low self-efficacy regarding using a given technology.

Each teacher has different characteristics; these differences influence the learning process that will be carried out. These differences can influence the way teachers integrate ICT in learning. Teaching experience is one factor that can cause differences between teachers in implementing ICT. Research conducted by Gilakjani (2013) found that more experienced teachers have better ICT self-efficacy. However, the findings of Kwon et al. (2019) showed different results, where teachers with less teaching experience had higher ICT self-efficacy than senior teachers.

Apart from teacher background, school factors can also influence teachers' ability to integrate ICT, which can be reflected in ICT self-efficacy, such as school status (Joshi et al., 2021). Based on the status of schools in Indonesia, they are divided into two groups: state and private. *Public schools* are schools that the government directly manages, while foundations manage private schools. Pekanbaru is a city in Riau Province which has the highest number of SMA/MA with a total of 67 schools consisting of 22 State SMA/MA and 45 Private SMA/MA (Kemendikbud, 2023) and has more supportive ICT facilities such as good internet network quality to integrate ICT into learning (Farida & Nurhaliza, 2022)

The purpose of this study is to describe the differences in teachers' self-efficacy in using ICT for teaching practice-based teaching experience and school status and determine the magnitude of the difference between two groups. Therefore, this perspective can be one direction for policymakers to decide how to develop teachers' ICT self-efficacy. This research will answer the following problem formulation using a cross-sectional survey method: (1) Is there a significant difference in

chemistry teachers' ICT self-efficacy based on teaching experience and school status in Pekanbaru High School? (2) What is the effective contribution of teachers' teaching experience and school status to chemistry teachers' ICT skills self-efficacy in Pekanbaru High School?

Method

This research is descriptive research with a quantitative approach. The method used to collect data is the survey method. The type of survey used in this research is a cross-sectional survey, one of the most popular forms of survey design in the world of education (Creswell, 2012). This type of cross-sectional survey was chosen because it fits the research objectives to focus on studying, comparing, and describing the ICT self-efficacy participant.

The research was conducted in 31 high schools in Pekanbaru City and included a randomly selected sample of 50 chemistry teachers. Data collection techniques in this research are non-test techniques in the form of questionnaires and interviews. The interviews in this research aim to strengthen the research results. The instruments used in the analysis resulted from synthesis from several experts. In this study, the scale used to measure chemistry teachers' ICT self-efficacy and ICT skills was a Likert scale, ranging from 1 strongly disagree to 5 strongly agree (Gbemu et al., 2020).

Table 1. Demographics Information of Respondent

Characteristic	Category	f	%
School status	Public school	31	62%
	Private school	19	38%
Teaching	< 20 years	29	58%
experiene	≥ 20 years	21	42%
Age	21 – 30 years	9	17.30%
	31 – 40 years	11	21.15%
	41 – 50 years	20	38.46%
	51 – 60 years	10	21.15%
Gender	Male	6	12%
	Female	44	88%
Certification	Yes	34	68%
Status	No	16	32%

Data from this study was collected through valid and reliable questionnaires developed during the research. The instrument in this study consisted of 14 ICT self-efficacy items. The data analysis technique used is inferential statistics using descriptive statistic, two-way ANOVA test and effect size test. Descriptive analysis functions to classify data that still needs to be organized into an orderly structure that is easy to interpret. Data analysis includes determining categorization criteria, calculating descriptive statistical values, and describing variables. The two-way ANOVA analysis aims to see differences in teachers' ICT self-efficacy while the effect size test aims to measure the magnitude of the difference between two groups. In this study, the way to measure effect size can look at the value of partial eta square. Referring to Cohen's criteria, the effect size can be divided into three categories, namely the partial eta square value of 0.01 indicates a small effect, 0.06 indicates a moderate effect, and 0.14 indicates a large effect (Lakens, 2013). Statistical calculations were carried out using SPSS version 25. A significance value of ≤ 0.05 indicates a difference between the two groups.

Table 1. Determining Categorization of ICT Self-Efficacy

Score	Category
X > Mi + 1.8 SBi	Very High
Mi + 0.6 SBi < X ≤ Mi + 1.8 SBi	High
Mi – 0.6 SBi < X ≤ Mi + 0.6 SBi	Enough
Mi – 1.8 SBi < X ≤ Mi – 0.6 SBi	Low
X < Mi – 1.8 SBi	Very Low

(Widoyoko, 2019)

Result and Discussion

This section contains any research results that answer the research questions asked. The findings of this study include a questionnaire regarding differences in ICT self-efficacy of chemistry teachers in Pekanbaru City based on teaching experience and school status.

Validity and Reliability of Instrument

The validity and reliability of the instrument were obtained based on analysis of the results of trials on 25 chemistry teachers who were not the research sample. Instrument validity and reliability testing was carried out using the Jeffrey's Amazing Statistics Program (JASP) software program. Validity testing uses the Rasch model, which is included in modern measurement theory by grouping item and person calculations into distribution maps.

Table 2. Results of Exploratory Factor Analysis

Instruments	Valid Items	Kaiser Mayer-Okin	Barlett's Test	Cronbach's α
ICT self-efficacy	14	0.720	p < 0.01	0.928

Rasch Model analysis with exploratory factor analysis with Kaiser-Meyer-Okin was used to determine whether the sample size was sufficient. (Kosar & Besen, 2019). If the KMO-MSA value is less than 0.5, the item is declared invalid and must be removed from the factor analysis one by one, starting from the smallest value (Hair et al., 2014). The results of the validity test on the

ICT self-efficacy instrument for chemistry teachers show that 14 items are valid with an overall MSA value of 0.720 and reliable with a Cronbach's α value of 0.928. This instrument has reached safe limits with values as in table 2.

Research Instrument

The questionnaire in this research was developed based on the synthesis results of several experts. The questionnaire includes, among other things, statements about teacher confidence in mastering ICT, teacher confidence in designing ICT-based learning, teacher confidence in using ICT tools, and teacher confidence in implementing ICT-based learning.

The research instrument also contains teacher data such as name, age, gender, school status and teaching experience. Teachers are asked to fill in the data according to the conditions of each teacher.

Table 3. Item Questionaire

Item 1	I feel confident using computers in learning activities
Item 2	I am confident that I can learn the latest technology related to learning chemistry
Item 3	I'm not sure that I can keep up with the latest technological
Item 4	I feel confident that I can choose the right learning technology according to the learning topic
Item 5	I can easily prepare lesson plans that require me to use instructional technology
Item 6	It is easy for me to find instructional technologies that are relevant to my teaching.
Item 7	I'm not sure I can evaluate learning using ICT
Item 8	I can use LCD projector to present lessons
Item 9	I feel confident when teaching using PowerPoint in learning activities
Item 10	I am not sure that I can use ICT media such as videos to support chemistry learning activities
Item 11	I am afraid that it will be overwhelming to monitor students if asked to use ICT in chemistry learning
Item 12	I believe that I can solve technology-related problems myself
Item 13	I believe that I can guide students to use ICT to analyze information to gain new understanding.
Item 14	I'm not sure I can maintain students' attention when using ICT in learning

Descriptive Statistic

Descriptive statistics in this study provide a description of the data seen from the average value and categorize it into certain levels. Table 4 show that there is a significant difference in the average ICT self-efficacy scores and ICT skills of chemistry teachers between teachers who have <20 years and ≥20 years of teaching experience. Teachers with less than 20 years of teaching experience had a higher ICT self-efficacy score, namely 64.34, and ICT chemistry teachers with more than 20 years of teaching experience had a lower score, namely 58.38. Based on school status, there is a difference in the average ICT self-efficacy scores and ICT skills of chemistry teachers between chemistry teachers who teach in state schools and private schools. But the average difference is not that significant. The average ICT self-efficacy score of public school chemistry teachers in Pekanbaru is 61.45, while the average score of private school chemistry teachers is 62.47.

Table 4. Descriptive Statistic

Variable	Group	N	Average	Criteria
ICT self-efficacy	<20 years	29	64.34	Very high
	≥20 years	21	58.38	High
	Public school	31	61.45	Very high
	Privat school	19	62.47	Very high

Two-way ANOVA

A two-way ANOVA test was carried out to answer the research hypothesis whether there were differences in ICT self-efficacy based on teacher teaching experience and school status simultaneously and respectively. The two-way ANOVA test was chosen because, in this study, there are two independent variables, so differences can be seen simultaneously based on whether or not there is an interaction between the two factors. The requirements for data normality and homogeneity have been measured, and a value of > 0.05 ensures conformity.

Table 5. Two-way ANOVA Test

Source	Type II sum squares	df	Mean square	F	Sig	Partial Eta Square
School status (ss)	3.318	1	3.318	.077	.783	.002
Teaching experience (te)	378.504	1	378.504	8.757	.005	.160
ss*te	.345	1	.345	.008	.929	.000

a. R Squared = .180 (Adjusted R Squared = .127)

Table 5 shows the significance value of the school status factor is 0.783, which means there is no difference in ICT teacher self-efficacy, while the significance value based on teacher teaching experience is 0.005, which means there is a difference in ICT teacher self-efficacy. It can be understood that school status does not influence teacher self-efficacy in using ICT in learning, while the teacher's teaching experience factor influences chemistry teachers' ICT self-efficacy. These two factors do not have an interaction that influences the chemistry teachers' ICT self-efficacy.

The teacher's teaching experience in this research is the number of years a teacher has taught chemistry. Teachers' teaching experience was divided into two groups: teachers who taught <20 years and ≥20 years. The grouping year ranges are selected to obtain a proportional sample for each group. Chemistry teachers with <20 years of teaching experience have higher ICT self-efficacy in using information and communication technology in chemistry learning. Teacher ICT self-efficacy is the teacher's self-confidence in his ability to master, design, use ICT tools, and implement ICT-based learning. The research results above are similar to the findings of Kwon et al. (2019), which stated that teachers with less teaching experience had higher levels of ICT self-efficacy. Teachers with 20 years or less of work experience still have good motivation to adopt technology. Teachers with more than 20 years of work experience have much teaching experience. However, they are found to have decreased motivation or a low tendency to learn new things, especially those related to technology (Afshari et al., 2009).

Based on the results of the effect size test, it shows that the value of partial eta square or effective contribution given by teaching experience is included in the high category of 0.16, this means that 16% of the variance in the dependent variable (ICT self-efficacy) can be explained by the teaching experience factor. From these results, the magnitude of the difference in ICT self-efficacy between chemistry teachers whose teaching experience is <20 years and ≥20 years is 16%. Educators with higher ICT self-efficacy are most likely to use ICT in their classrooms and are least likely to suffer from ICT-related anxiety (Hori & Fujii, 2021; Mlambo et al., 2020). Teachers with high ICT self-efficacy are more open to embracing innovative technologies and are interested in experimenting with new pedagogical methods that integrate ICT (Mlambo et al., 2020). Research results from (Hatlevik & Hatlevik, 2018)noticed that teachers who used technology such as computers more often had higher levels of ICT self-efficacy. They are more open to new ideas and more likely to successfully use ICT in the classroom. The findings above are similar to the research results Ghavifekr & Rosdy (2015), which state that teacher efficacy in using technology decreases with increasing years of experience and age.

Based on the results of the interview, the teacher also expressed similar things, as in the following quote: "Of course, I like and enjoy using ICT in chemistry learning because I was used to using ICT tools at college, and now I am a teacher" (Respondent, 2023). "I do not feel afraid or anxious about using ICT in learning because before the Covid-19 pandemic, mothers often used ICT, plus with the pandemic, they have increasingly used ICT because learning is online" (Respondent, 2023).

Morelock et al. (2015) stated that as teachers increase their experience and age, their knowledge and technical skills about technology become a significant factor. Younger teachers will understand technology more efficiently than more senior teachers; this is because young teachers are more willing to try new things, while more senior teachers are comfortable with the existing system. Based on the results of interviews with teachers, it was found that teachers with <20 years of teaching experience more often took part in training (online and offline) on ICT in learning, such as making videos, making e-books, and virtual laboratories. Teachers with teaching experience <20 years are more active in searching for information about ICT for online learning.

Teachers accustomed to traditional methods are less likely to use modern tools in their teaching. In addition, teachers with more teaching experience think they are too old to adapt to new ICT tools and want to avoid accepting the latest teaching methods. More experienced teachers do not acquire new skills due to their lack of resilience towards technology (Raman & Yamat, 2013). Okas et al. (2014) revealed that the leading cause of the difference in teachers' ICT self-efficacy between teachers with less teaching experience and teachers with more teaching experience lies in perceptions about ICT, where younger teachers have greater expectations regarding ICT tools and digital learning, while teachers who having a more extended teaching period views learning with technology as less than optimal. Rogers (2003) revealed that the characteristics of later majority innovation adopters are usually older, less confident in innovation, very careful, and have suspicions and doubts about the function and benefits of creation, so it takes a little longer to accept and implement new innovations.

The school status factor shows different results from the teacher's teaching experience. School status does not affect teacher ICT self-efficacy. The results of the analysis show that there is no difference in ICT self-efficacy between chemistry teachers who teach in public high schools and private high schools. The effective contribution given by school status is very low at 0.2%. These results are similar to the findings of Buabeng-Andoh (2015), who stated that there was no significant difference in ICT self-efficacy between teachers who taught in public and private schools. Although there are no differences, in general, the ICT self-efficacy of chemistry teachers in public and private high schools is in the high category. Based on the interview results, it was found that teachers currently feel more confident and enjoy using technology because they are already

familiar with it. Public and private high school teachers stated that they learned to conduct learning using ICT and designed and implemented ICT-based learning during the COVID-19 pandemic, so they used ICT more often. Therefore, chemistry teachers teaching in public and private high schools have high ICT self-efficacy.

The learning system changed during the COVID-19 pandemic in 2020. Learning initially carried out face-to-face in class has shifted to online learning with the help of ICT. From primary to higher education, public and private high schools carry out online learning (Pernantah et al., 2021). With this change in the learning system, teachers who previously could not use ICT must inevitably learn to improve their skills in using ICT so that learning can still be implemented (Latiafah & Hidayati, 2021).

Online learning during the pandemic is something new for educators and students. They must use technological assistance such as Zoom, Meet, Google Classroom, and others to help the learning process (Fuady, 2016). Not only does the learning process continue to adapt in implementing teacher evaluations, but there are also obstacles where teachers must think about the most effective way to carry out learning evaluations. Implementing ICT-based online evaluation via computer devices in online learning has become necessary (Andriani et al., 2023). Teachers are required to learn how to carry out online evaluations. Therefore, chemistry teachers' ICT self-efficacy is the same in using ICT.

The following finding from this research is that there is no interaction between the factors of teacher-teaching experience and school status. The previous separate analysis showed that teacher teaching experience made a significant difference to ICT self-efficacy, while school status did not make a difference to ICT self-efficacy. Therefore, there is no difference in teachers' ICT self-efficacy based on a simultaneous analysis of teachers' teaching experience and school status factors.

Conclusion

Based on the results of the research show that there is a difference in the ICT self-efficacy of chemistry teachers in Pekanbaru City based on the teacher's teaching experience, while based on school status, there is no difference in the ICT self-efficacy of chemistry teachers in Pekanbaru City, whether they teach in State High Schools or Private High Schools. The effect size test shows that the partial eta square value for the effect of teaching experience belongs to the high category while school status belongs to the low category, this means that the teaching experience has a greater influence on the ICT self-efficacy of chemistry teachers than school status.

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Author Contributions

I.E.Y as the main author created the concept or idea for the article, designed the method used, conducted research from several journals by the theme of the article analyzed the data, and wrote the article; H. S who always provides direction and guidance regarding the review of this article, starting from planning the review and conducting a content analysis on the article as a whole.

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Conflicts of Interest

The authors declare no conflict of interest.

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