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Prospective Biology Teachers Perceptions of CT, ICT and TPACK Skills

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Abstract: The Covid-19 pandemic has caused the learning process to change from face-to-face to online learning, without exception it has also occurred at Islamic Universities in Indonesia. Therefore, an online learning design with WhatsApp and Google Classroom was conduct to improved critical thinking (CT), information communication and technology (ICT), and technological pedagogical content knowledge (TPACK) of Prospective Biology Teachers in Islamic Universities (PBTs-IU). The aims of this study was to investigate prospective biology teacher's perceptions of critical thinking, ICT and TPACK skills of during the Covid-19 pandemic. This study used quantitative descriptive method. Data were collected from 195 PBTs-IU, with of 19 males and 176 females. The quality of the instrument was achieved use confirmatory factor analysis (CFA) and alpha Cronbach tests. Then, paired sample correlations test was used to confirmed the hypothesis. The result of the study showed that there is different with CT, ICT and TPACK skill pre-course with post-course PBTs-IU. This finding also showed that score CT, ICT and TPACK of PBTs-IU for post-course is higher than pre-course. In concluded, there was a significant difference score for pre-course and post course about prospective biology teacher's perceptions of CT, ICT and TPACK skills of during the Covid-19 pandemic.

Keywords: Critical thinking; information communication and technology; technological pedagogical content knowledge

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INTRODUCTION

As of 15th April 2020, 191 countries had closed their schools affecting 1.6 billion children. Many education systems responded by rapidly setting up remote learning systems to provide learning continuity. However they faced numerous challenges in doing so: (a) Students not having have access to the internet or certain devices; concerns about student safety / privacy online; (b) Teachers being unfamiliar with remote-learning solutions; difficult adjusting subjects or learning activities to remote learning formats; (c) Solutions being unevenly distributed by age, subject, and / or language, with considerable long-term costs even if they are provided initially for free; (d) Education-system decision making is uneven across administrative levels, and systems are facing limited budget, digital maturity, and operational capacity (Unesco, 2020). In Indonesia, education system also responded this situation with change the learning system. The Covid-19 pandemic in Indonesia has caused the learning process to change from face-to-face to online learning. Thus, blended learning was a method of learning that has been chosen to carry out the learning process.

The conditions have forced the Indonesian ministry of national education to continue to impose distance learning for every level of education. Based on official information, the Ministry of Education and Culture (Kemendikbud) has currently prepared learning scenarios, including encouraging online learning for students. One of the learning

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programs that have been implemented is a learning program that also accommodates online learning. Online learning programs with independent learning are very appropriate to be applied during the Covid-19 pandemic (Abidah et al., 2020)

Studies on learning with Google Classroom during the pandemic in Indonesia show that the application of google classrooms as a learning platform for teaching can be applied and accepted by students, and the use of google classrooms has led to better student learning outcomes (Tinungki & Nurwahyu, 2020). Learning with google classrooms in Indonesia shows that learning has been well managed by the teacher, where students have high learning independence and moderate critical thinking skills (Rahmad et al., 2019). Furthermore, the use of google classroom in Indonesia has also been used to improve the quality of learning (Ketut Sudarsana et al., 2019), student achievement (Rahiem & Mochtar, 2001). However, the study findings need to be proven by conducting other studies. Thus, this study proves that the use of google classroom and social media WhatsApp during the pandemic in Indonesia can also be well received by prospective biology teacher students (PBTs) at the Islamic University in Indonesia.

Critical thinking (CT), information communication and technology (ICT) and technological pedagogical content knowledge (TPACK) including 21st century skills (Haviz et al., 2020; Haviz, Lufri, et al., 2020; Haviz, Maris, et al., 2020; Haviz & Maris, 2020). Critical thinking is a competency which is being required from students in their personal and professional life (Bezanilla et al., 2019), and since technological pedagogical content knowledge (TPACK) was first developed by Shulman (2013). In the previous study showed that critical thinking and Information, communication and technology skills in higher education were two important skills to teach in a higher education classroom (Smith et al., 2018). The study about applied the design thinking approach to information technology course and the results suggested that design thinking can promote the student achievement (Cáceres et al., 2020; Lin et al., 2020). In others, critical thinking uses by teachers in their teaching (Bezanilla et al., 2019) and promoting students' critical thinking is an important task of teacher education (Lorencová et al., 2019). According to Gudmundsdottir et al., (2020) the ability of prospective teacher students to use the internet responsibly is an important part of early teacher education. Including the higher use of ICT in schools has a positive effect on outcomes in science learning (Fernández-Gutiérrez et al., 2020). In conclusion, the assessment of ICT for prospective student is important and can promote the student achievement (Fernández-Gutiérrez et al., 2020; Fjørtoft, 2020).

Chai et al., (2013) have reviewed 74 articles examining ICT integration with TPACK. This review advises readers to research and develop technology based on TPACK, study the concept of student learning with technology and use TPACK in learning, by integrating with various study frameworks. In other reports, it shows that TPACK is an important competency for students to master, especially student teacher candidates. The results of these studies also show that mastery of TPACK increases along with the increase in mastery of information communication and technology (ICT) skills. These results are found in various articles written by (Chai et al., 2015; Koh, 2013; Koh et al., 2010, 2014). These reports also clarify the relationship between TPACK and ICT as part of 21st century skills. However, the articles written by Koh et al., (2014) and his colleagues only suggest teaching TPACK and ICT in an integrated manner and have not researched and reported how to teach TPACK with ICT in an integrated manner in the learning process. So, this condition raises

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the question, what is the appropriate way of teaching to improve the TPACK and ICT skills of students in the classroom.

Previous research showed that TPACK was investigated by survey method. Chai et al., (2011) used a survey method to investigate the modeling primary school pre-service teachers' TPACK for meaningful learning with ICT. Koh et al., (2015) conducted a survey to examine teachers' perceptions of design dispositions, lesson design practices, and their relationships with TPACK. However, these findings have gaps in the aspect of instrument access. These statements were found in the study was conduct by Siddiq et al., (2017). The study showed that there was gap revealed in the literature regarding the limited access to assessment instruments to measure student ICT literacy which also affects to the student achievement. So, this gap becomes an opportunity for further studies to explore ICT skill, and others skill such as CT and TPACK.

METHOD

Data were obtained from 195 pre-service biology teachers (PBTs) who are studying at the Biology Education Department of IAIN Batusangkar, West Sumatra Indonesia. These Prospective biology teachers (PBTs) come from six different classes. The number of students is 19 male and 176 female Prospective biology teachers (PBTs) have ages 18 to 22 years, with an average age of 20.5 years. The instrument used to capture of TPACK PBTs skills, the researcher modified the instruments developed by Koh, (2013) and the instruments used by Lee & Kim (2014). These two instruments were chosen because of the many similarities in student characteristics. Both instruments have been adapted to the needs of the research. The indicators of this instrument are content knowledge, pedagogical knowledge, technological knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical knowledge content knowledge.

Researchers modified the instruments developed by Haviz et al. (2020a) and Haviz & Maris (2020) to capture responses to mastery of CT skills and ICT PBTs. Indicator for CT; apply, evaluate, uses data to develop critical insights, analyze, synthesize. Indicators for ICT; ICT finds, uses multiple sources, selects, evaluates, knows computer-based technologies, digital and multimedia products, technicality, design, selection, and utilization, legal / ethical. In this study, we used the two instruments CT and ICT, and TPACK. The validity and reliability tests used the CFA and alpha Cronbach methods to determine the goodness and structure of the instrument used for the research data collection (Hu & Bentler, 1999). In this study, the loading factor used was above and below 0.1, on the relevant and irrelevant factors, respectively. The data shows that the validity score is in the range 0.04-1.55, with the TPACK coefficients above *0.1*. This finding showed that all items of the TPACK questionnaire statement were valid, with the two questionnaires consisting of a good level of reliability. Cronbach's Alpha score for the TPACK questionnaire was *0.920* with *N=30* items. For CT and ICT instrument, the validity and reliability tests used the CFA and alpha Cronbach methods to determine the goodness and structure show that the instrument was valid. The score for validity of CT and ICT instrument was *Chi-Square 2,69*; *df=2 P-value 0.26087* and value *RMSEA=0.045*. The reliability score with *Cronbach's alpha* is *0.844*. Finally, it was concluded that the two questionnaires in this study were valid and reliable and used to collect further research data.

Prospective biology teachers (PBTs) have studied scientific literacy, scientific writing, and research methodology. This online learning has been carried out using WhatsApp,

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google classroom and google meet as learning media. The prospective biology teachers (PBTs) studied for 16 meetings and were taught by the same lecturers. The lecturer has designed the learning material then uploads it to Google Classroom. So that students can study the material before the learning process is carried out. Online face-to-face meetings were conducted using google meet for 4 meetings, namely meetings 1, 7, 10, 15, and other meetings were held with the google classroom. Communication and interaction between lecturers and students have been carried out with WhatsApp.

The instrument in the form of a valid and reliable google form was filled in by PBTs. PBTs filled out the instrument twice, the first meeting and the 16th meeting. Mean, standard deviation and standard error mean was used to determine the descriptive score for pre-course and post course. Also, statistic inferential with paired sample correlation test was used to determine differences of score for pre-course and post course.

RESULT AND DISCUSSION

The difference in pre-course and post-course scores for PBTs CT skills

The result of descriptive statistic showed that mean score for CT skill of PBTs at pre course = *10.87*, standard deviation = *4.82* and standard error mean = *.45*. The mean score for CT skill of PBTs at post course = *14.16*, standard deviation = *3.66*, standard error mean = *.34* (see **Figure 1** and **Table 1**). Data from Table 1 showed that the mean score for CT skill of PBTs at post-course is higher than the mean pre-course (*14.16> 10.87*). This result also showed that there is a significant correlation which is indicated by the *sig. value. 0.000 <0.05*. The result of the paired sample correlations test showed that there was a significant difference in CT skill of PBTs pre-course and post course, with the *sig. value. 0.000 <0.05*. The result of the paired samples test (*sig. 2 tailed*) found with score of *t = -4.825*.

The difference in pre-course and post-course scores for PBTs ICT skills

The result of descriptive statistic showed that mean score for ICT skill of PBTs at pre course = *20.92*, standard deviation = *8.64* and standard error mean = *.81*. The mean score for CT at post course = *30.18*, standard deviation = *5.56*, standard error mean = *.52* (see **Figure 2** and **Table 2**). Data from Table 2 showed that the mean score for ICT of PBTs at post-course is higher than the mean pre-course (*30.18> 20.92*). This result also showed that there is a significant correlation which is indicated by the *sig. value. 0.000 <0.05*. The result of the paired sample correlations test showed that there was a significant difference in ICT skill of PBTs pre-course and post course, with the *sig. value. 0.000 <0.05*. The result of the paired samples test (*sig. 2 tailed*) found with score of *t = -9,381.*

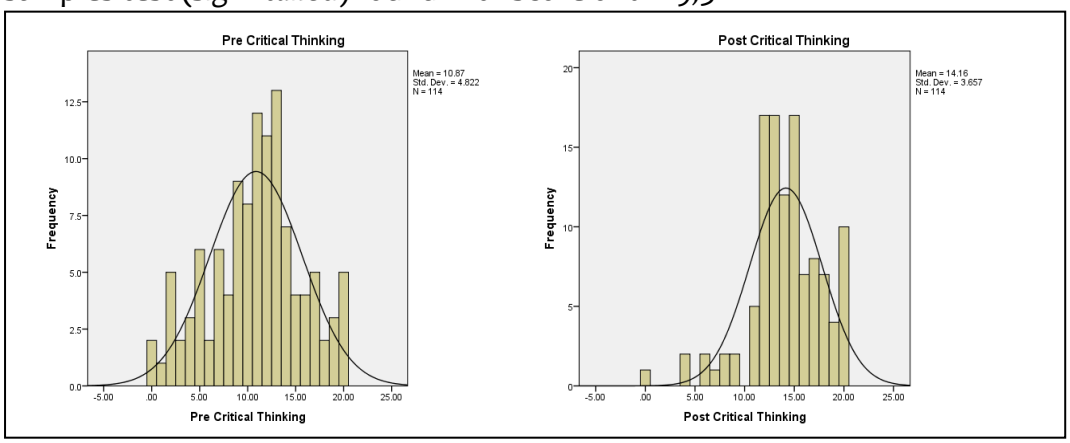


Figure 1. Descriptive statistics in pre-course and post-course scores for PBTs CT skills

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Table 1. Inferential statistic in pre-course and post-course scores for PBTs CT skills

	Pre-Course	Post-Course
Paired Sample Statistics		
N Sample	114	114
Mean	10.87	14.16
Standar Deviation	4.82	3.66
Standar Error Mean	.45	.34
Paired Sample Correlations		
Correlation	**-.464**	
Sig	**.000**	
Paired Samples Test (Sig 2 tailed)		
t	**-4.825**	
df	113	
Sig. (2 tailed)	.000	

The difference in pre-course and post-course scores for PBTs TPACK skills

The result of descriptive statistics showed that the mean score for TPACK skill of PBTs at pre course = *80.48*, standard deviation = *19.95* and standard error mean = *1.87*. The mean score for TPACK skill of PBTs at post course = *92.47*, standard deviation = *17.09*, standard error mean = *1.60* (see **Figure 3** and **Table 3**). Data from Table 3 showed that the mean score for TPACK skill of PBTs at post-course is higher than the mean pre-course (*92.47> 80.48*). This result also showed that there is a significant correlation which is indicated by the *sig. value. 0.000 <0.05*. The result of the paired sample correlations test showed that there was a significant difference in TPACK skill of PBTs pre-course and post course, with the *sig. value. 0.000 <0.05*. The result of the paired samples test (*sig. 2 tailed*) found with score of *t = -16,424*.

The findings of this study indicate that the use of Google Classroom and WhatsApp in learning improves the ability of TPACK, CT and ICT PBTs at Islamic Universities. The findings of this study also showed that Google Classroom are suggested to be used in the learning process. These findings are in line with the previous studies that Google Classroom has provided benefits for learning in higher education (Kumar et al., 2020). Kumar & Bervell (2019); Bervell & Umar (2017) suggested exploring how Google Classroom is perceived and adopted in higher education.

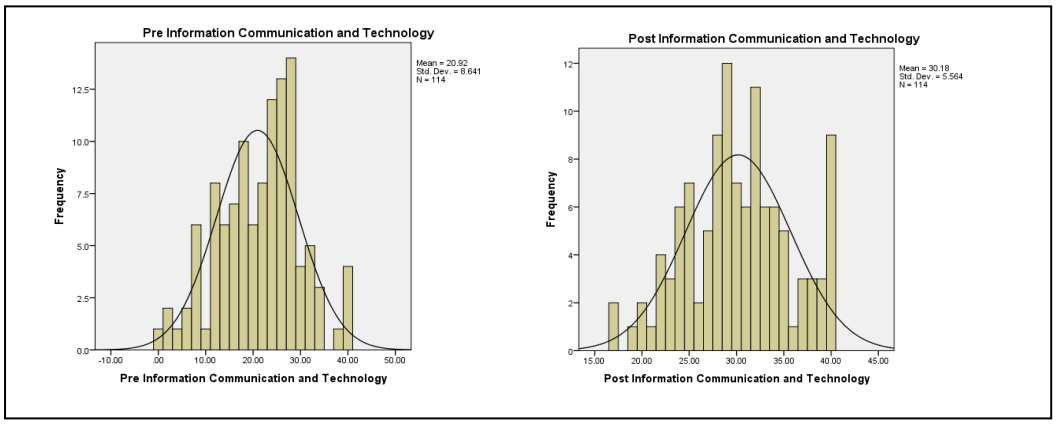


Figure 2. Descriptive statistics in pre-course and post-course scores for PBTs ICT skills

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Table 2. Inferential statistic in pre-course and post-course scores for PBTs ICT skills

	Pre-Course	Post-Course
Paired Sample Statistics		
N Sample	114	114
Mean	20.92	30.18
Standar Deviation	8.64	5.56
Standar Error Mean	.81	.52
Paired Sample Correlations		
Correlation	**-.055**	
Sig	**.559**	
Paired Samples Test (Sig 2 tailed)		
T	**-9.381**	
Df	113	
Sig. (2 tailed)	.000	

In others, the adaptation of Google Classroom in higher education can make better access to learning material and supplementary teaching resources, helpfulness of immediate feedback, and learning outside of class environment were reported by students (Dash, 2019). E-Learning facility like Google Classroom effectively helpful in classroom learning (Bhat et al., 2018). Google Classroom increased student participation and learning and improved classroom dynamics (Heggart & Yoo, 2018).

The results of this study indicate that the using of Google Classroom and WhatsApp is a part of learning management systems (LMS) in 21st century learning. The using of LMS in 21st century learning continues to expand, driven by the ubiquitous access to the internet and continued exploration in social networks, media, and games as spaces for learning and collaboration (Reshad, 2018). The learning management system (LMS) is a virtual learning environment (VLN) that is used to deliver course material, track progress, and conduct assessments for e-learning. Finally, learning management systems (LMS) represent one of the main technologies to support learning in higher education institutions (Abazi-Bexheti et al., 2018).

There has been a rush towards online learning by education systems during COVID-19, this can therefore be seen as an opportunity to develop students' higher-order thinking skills, and critical thinking and creativity can be developed in an online context (Nussbaum et al., 2021). The findings of Lacka et al., (2021) show that students who use social media are the least efficient in achieving higher education goals and higher education institutions should not over-privilege digital tools especially post-covid-19. However, the findings of this study show that online learning carried out with Google Classroom and WhatsApp can improve CT, ICT and TPACK PBTs skills at Islamic university in Indonesia.

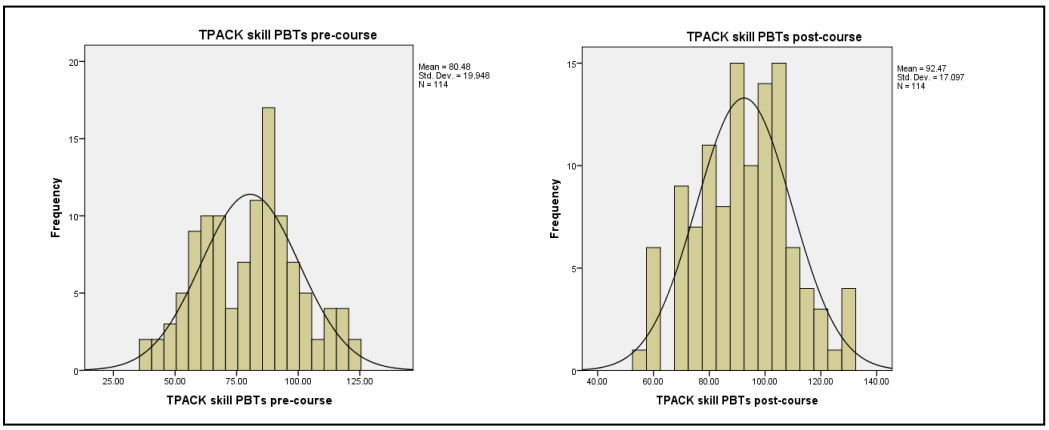


Figure 3. Descriptive statistics in pre-course and post-course scores for PBTs TPACK skills

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Table 3. Inferential statistic in pre-course and post-course scores for PBTs TPACK skills

	Pre-Course	Post-Course
Paired Sample Statistics		
N Sample	114	114
Mean	80.48	92.47
Standar Deviation	19.95	17.09
Standar Error Mean	1.87	1.60
Paired Sample Correlations		
Correlation	**.923**	
Sig	**.000**	
Paired Samples Test (Sig 2 tailed)		
t	-16.424	
df	113	
Sig. (2 tailed)	.000	

Since the Covid-19 pandemic, TPACK has become a hot topic discussed by researchers in the field of education. Although, in the previous decade, this topic had often been studied by previous researchers, this topic remains a hot topic to be researched and discussed. Before the Covid-19 pandemic, there were also many studies that examined TPACK for pre-service teachers. There is research that examines the application of teaching methods to improve students' TPACK abilities. For example, the research results of Haviz et al. (2020a). The research has been conducted to determine the relationship between teaching experience, and teaching ability of Islamic university mathematics and science lecturers (IU-MSLs) with TPACK, and the result of the research showed that different teaching abilities and experience still consider TPACK as an important competency to be mastered by IU-MSLs. The result of the research was conduct by Dong et al., (2015) also show that the teachers strongly believe that constructivist oriented teaching is a factor that influences TPACK. Koh, Chai, Wong, et al., (2015) has suggested using five types of teaching methods to construct the TPACK rubric; active, constructive, authentic, intentional and cooperative learning. So, these rubrics can be used as a guide for teachers to develop TPACK activities in various learning subjects. These findings show that TPACK is a skill that student teacher candidates should master well. Online learning is the main reason TPACK is a skill that pre-service teachers must learn, including PBTs.

The results of this study show that TPACK, CT and ICT are 21st century skills needed by prospective teachers, so they must be given to students in the learning process (Haviz, Maris, et al., 2020; Suwono et al., 2017). Technological pedagogical content knowledge (TPACK) was needed by teacher (Elas et al., 2019). According to Afandi et al., (2019) TPACK is a 21st-century skill that needs to be possessed by teachers. Thus, in the last decade, 21st century skills assessment is one of the "hottest" topics in education (Geisinger, 2016; Greenstein, 2012). The term 21st century skills has developed as a key concept and slogan in education (Greiff & Kyllonen, 2016). Because 21st century skills are needed by students to prepare for future life (Larson & Miller, 2011), or after graduation (Kaufman, 2013). Including with the aim of studying 21st century competencies in curriculum and special subject education is also an important issue around the world (Wang et al., 2018).

In other articles it has been explained that there are types of 21st century skills that are needed by students, such as collaborative problem solving, complex problem solving, creativity, and digital information literacy (Geisinger, 2016). Some of the other 21st century skills that are also needed by students are reasoning, collaboration and self-regulation (Ahonen & Kinnunen, 2015), computers and information literacy (Ainley et al., 2016). Thus,

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this explanation has shown that 21st century skills are needed by students, and the results of this study are in line with the relevance of these articles and reports.

The articles have reported on investigating 21st century skills in learning. Haviz et al. (2020b) have evaluated the thinking, acting and living skills of prospective mathematics and science teacher students at Islamic university in Indonesia. The results of this study indicate that the students' level of mastery of 21st century skills is at a moderate level. This research shows that teaching methods and skill types are factors of 21st century skills. This study recommends the need to improve lecturers' teaching strategies by integrating thinking, acting and living skills with ICT skills. The results of this study have similarities between this research and the research to be carried out, namely (a) the use of surveys to reveal the thinking and acting skills of prospective teacher students, (b) several instruments developed by previous researchers will be used in this research and (c) use of techniques CFA and EFA to validate the instrument will also be used to assess the 21st century skills of prospective teachers.

This study is an example of a way of learning that is still being carried out during the Covid-19 period. The findings of this study also show that there is an increase in the skills of CT, ICT and TPACK PBTs in learning that has been done during the Covid-19 pandemic. This finding is in line with that opinion enhancing students' CT is an essential goal of higher education (Bravo et al., 2020). A design framework for enhancing engagement in student-centered learning (Lee & Hannafin, 2016) to transforming student engagement in Covid-19 remote instruction was conduct and given the many uncertainties associated with the "shift to digital" as a result of Covid-19, the OLSit model is very applicable for research by teachers, student teachers, and teacher educators (Edyburn, 2021). Research that has been conducted by Karwowski et al., (2020) supports the opinion by Bravo et al., (2020). Karwowski et al., (2020) has also conducted a preregistered experiment examined the effects of covid-19 pandemic on insight and analytic thinking, and the result showed that no support for our a-priori hypothesized effect (decrease in insight problem solving and no change in analytical thinking).

CONCLUSION

This study was found that there is difference in pre-course and post-course scores for prospective biology teachers (PBTs) critical thinking (CT). There was difference in pre-course and post-course scores for prospective biology teachers (PBTs) information communication and technology (ICT) skills at Islamic university. There was difference in pre-course and Haviz post-course scores for prospective biology teachers (PBTs) technological pedagogical content knowledge (TPACK) skills at Islamic university. In concluded, there was a significant difference score for pre-course and post course about prospective biology teacher's perceptions of CT, ICT and TPACK skills of during the Covid-19 pandemic.

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