

# Assesing PBTs (Final to JP11)

*by* M. Haviz

---

**Submission date:** 17-Sep-2020 09:17PM (UTC+0700)

**Submission ID:** 1389449277

**File name:** M.\_Haviz-Final\_Manuscript.pdf (506.67K)

**Word count:** 6753

**Character count:** 36411



## ASSESSING PROSPECTIVE BIOLOGY TEACHERS (PBTs) PERCEPTIONS ON THINKING AS A 21<sup>ST</sup> CENTURY SKILL: A CASE STUDY AT ISLAMIC UNIVERSITY

M. Haviz<sup>1</sup>, Lufri<sup>2</sup>, I. M. Maris<sup>3</sup>

<sup>1,3</sup>Institut Agama Islam Negeri (IAIN) Batusangkar, Indonesia

<sup>2</sup>Universitas Negeri Padang, Indonesia

DOI: 10.15294/jpii.v9i3.24077

Accepted: April 17<sup>th</sup> 2020. Approved: X<sup>th</sup> 2020. Published: X<sup>th</sup> 2020

### ABSTRACT

The explanatory mixed-method was conducted to assess prospective biology teachers' (PBTs) perceptions on thinking as 21<sup>st</sup> century skills. Data were collected using a quantitative survey method, and an interview with PBTs from Islamic University. 168 (14 men and 154 women) of 195 PBTs participated in filling out the questionnaire. The questionnaire consisted of 24 statements of aspects of critical thinking, problem-solving, creativity, metacognition of the 21<sup>st</sup> century skill. The confirmatory factor analysis (CFA) and alpha Cronbach tests were used to determine the quality of the instrument. Statistic descriptive, ANOVA, and correlation tests were conducted to analyze the quantitative data. Triangulation was conducted on the results of the interview. The results of the study indicate that (a) most male and female PBTs at Islamic universities have high skills in critical thinking and metacognition; (b) most male and female PBTs at Islamic universities have insufficient skills in problem-solving and creativity skills; (c) the results of this study also showed that there is no relationship between gender and PBTs skills. This study suggested that teachers and education managers in Islamic universities need to apply integrative learning by paying attention to the skills needed by PBTs. Learning applied in classrooms should be based on 21<sup>st</sup> century skills.

© 2020 Science Education Study Program FMIPA UNNES Semarang

Keywords: prospective biology teachers (PBTs); thinking; 21<sup>st</sup> century skill

### INTRODUCTION

In education, assessment of 21<sup>st</sup> century skills is the important issue (Geisinger, 2016), because it is conducted as a key concept and slogan in the field of education based on 21<sup>st</sup> century skills (Greiff & Kyllonen, 2016). Teo (2019) stated that over the past two decades, educators have determined strategies to prepare students and prospective teachers on how to navigate through the increasingly globalized world and inter-connected landscape associated with the 21<sup>st</sup> century. Because in the future, students need these skills (Larson & Miller, 2011). Additionally, Wang et al. (2018) reported that 21<sup>st</sup> century skills in the

curriculum have also become an important issue throughout the world. Thus, these explanations show that other studies of 21<sup>st</sup> century skills from various perspectives and important fields are to be carried out, including in studies of 21<sup>st</sup> century skills involving prospective teacher students in the field of biology education.

The problem of the study is the unclear classification and terminology of 21<sup>st</sup> century skills for prospective biology teachers at Islamic universities. Also, no studies have been stated that 21<sup>st</sup>-century skills must be mastered by prospective biology teacher students at Islamic universities. In fact, a study of 21<sup>st</sup> century skills is needed to determine the type of 21<sup>st</sup> century skills for prospective biology teacher students at Islamic universities. The study of 21<sup>st</sup> century skills at

\*Correspondence Address

E-mail: [mhaviz@iainbatusangkar.ac.id](mailto:mhaviz@iainbatusangkar.ac.id)

Islamic universities must be done to equip prospective biology teacher students with 21<sup>st</sup> century skills.

In fact, many previous studies have examined the 21<sup>st</sup> century skills for prospective biology teachers in public universities. The writers found a number of previous studies that have studied about 21<sup>st</sup> century skill for prospective biology teachers in public universities, such as critical thinking (Maryuningsih et al., 2019; Fitriani et al., 2019), metacognitive (Chang et al., 2020; Listiana et al., 2016), ICT (Aslan & Zhu, 2017), problem-solving (Nawani et al., 2019), generic science skill (Haviz et al., 2018), and creativity (Lucas, 2016). Maryuningsih et al. (2019) conducted quasi-experimental research to investigate the level of critical thinking skills (CTS) of 37 PBTs through online genetic discussion forums, and the results of the research showed that the level of critical thinking skills of PBTs increased based on the nature of chromosome inheritance learning through online discussion forums. Then, Fitriani et al. (2019) conducted research on the exploration of critical thinking of teacher candidates and critical analysis skills based on gender in anatomy and plant development courses, and the results showed that the PBTs critical thinking and critical analysis skills and found a positive correlation between the prospective teacher's critical thinking and critical analysis skills. Aslan & Zhu (2017) investigated that predicting variables Turkish pre-service science and other teachers' integration of ICT into teaching practice and found that the use of ICT in pre-service teacher teaching programs increased the pedagogical ability of pre-service teachers. Chang et al. (2020) conducted a study of metacognitive inquiry activities to teach the central dogma concept of DNA replication and protein synthesis based on the metacognitive learning cycle (MLC) for students, and the results of this study showed that students' metacognition was expressed during the investigation process. Listiana et al. (2016) conducted quasi-experimental research to compare the effect of group investigation (GI) strategy, think-talk-write, group investigation integrated with think talk write and conventional method on the students' metacognitive skills empowerment in the biology classroom, and the results of the research showed that the implementation of teaching strategies had an effect to empower students' metacognitive skills.

These previous studies also reported the importance of 21<sup>st</sup> century skills in learning biology. However, these studies have not classified the skills into clearer terminology. Also, these

studies only explore one skill in learning biology. In fact, many exploratory studies of 21<sup>st</sup> century skills can be done by teachers in the learning process. According to the writers, the terminology is needed to facilitate teachers integrating skills into the design and learning process. According to Zainuddin & Attaran (2016), the integrated learning process equips students with more competence needed by the students. Thus, it is necessary to conduct studies that explore the 21<sup>st</sup> century skills broader, for example examining the types of skills required by PBTs. In addition, the study should begin with a study of the development of 21<sup>st</sup> century student skills and assessment instruments (Sondergeld & Johnson, 2019).

Typically, the studies to examine the determination of prospective teacher-student views on 21<sup>st</sup> century skills have been carried out by designing and validating the instruments used to collect the opinions of research participants. Because the quality of the instrument determines the quality of the data collected during the study. In this study, the writers follow the opinions and results of studies that have been written by Sondergeld & Jhonson (2019), where the importance of assessing the development and validation of 21<sup>st</sup> century skills using various methods and approaches. The results of the Sondergeld & Jhonson's study (2019) also showed that there are processes of planning, development, quantitative and qualitative tests, and validation of 21<sup>st</sup> century skill instruments. In this study, the writers investigate thinking as a 21<sup>st</sup> century skill written by Greenstein (2012). According to Greenstein (2012), there are three classifications of 21<sup>st</sup> century skills; thinking, acting, and living, that are determined based on four skill levels. In this study, the use of the different levels of skills is assumed to be effective to capture responses of PBTs at Islamic universities in Indonesia. Because the 21<sup>st</sup> century skill assessment is effectively used at different levels of education.

In this study, the writers also investigated the relationship between gender and 21<sup>st</sup> century skills of PBTs, because the writers found differences in the results of studies reported by previous researchers who had examined the relationship between gender and skill, and gender with achievement. Although it is still being studied and debated, it is found that there are gaps in the learning outcomes of male and female students (Pederson, 2019; Alfarhan & Dauletova, 2019). For example, Ashraf's (2018) study presented that there was a statistically significant difference between female and male students' mean scores of the Jordanian students on 21<sup>st</sup> century skills

(Cs21). Sladek et al. (2010) reported that there are gender and age differences in the thinking process, of men, adults, and teenagers. In addition, the results of other studies show that the ability to analyze and draw conclusions for male PBTs is better than female PBTs (Fitriani et al., 2019). The findings of these three studies are understood as a form of a positive relationship between age and creative performance of students (Warren et al., 2018).

These explanations show that there is a gap that can be explored in this study. This study will be approved for these explanations. The prospective biology teachers' (PBTs) perception on thinking as 21<sup>st</sup> century skill in Islamic university was assessed by the three research objectives was to examine; (1) the quality of the thinking skills instrument of PBTs; (2) the profile of the thinking skills of PBTs; and (3) the difference in the thinking skills of male and female PBTs.

#### **Integrated Instruction at the Islamic University in Indonesia**

Integrated instruction is learning that explores student knowledge broadly by combining various subjects of knowledge with environmental aspects, for example, culture, communication, science, mathematics, social science, music, and art (Drake & Reid, 2018). Haviz (2016) explains that learning is characterized by the unification and use of several materials, strategies, methods, approaches, and other aspects of learning. According to the decision of the Directorate General of Islamic Education Ministry of Religion of the Republic of Indonesia Number 2498 in the year 2019, integrated instruction was a characteristic of studying Islamic universities in Indonesia. Previously, this integrated instruction was developed independently by each Islamic university in Indonesia. Since 2016, IAIN Batusangkar also implemented integrated instruction.

The application of integrated instruction during the learning process refers to the university's integrative learning guidelines. The application of this integrated instruction improves student skills and learning outcomes. For example, research conducted by Haviz (2016) and Haviz et al. (2016). Both studies have integrated embryology with the Quran at Islamic universities. There are integrated instruction research on their different respective content (Zainuddin & Perera, 2019; Agyei & Voogt, 2015; Holland & Piper, 2014). For example, Zainuddin & Perera (2019) identified the differences between a flipped classroom and a non-flipped classroom instructional model. The findings show that the out of class activities including the sharing of

short video clips uploaded on to the institutional learning management system for students' access before class had successfully established the basic psychological needs of self-determination theory.

However, a clear gap found in the application of integrated instruction in Islamic universities is not yet clearly determined by the type of skills needed by students. If it is related to the application in class, there are not many reports of studies on the application and type of skills needed by students. Therefore, this study investigates the skills required by PBTs at Islamic universities after the implementation of integrated instruction.

#### **Thinking as 21<sup>st</sup> Century Skill**

Thinking skill is part of the thinking, acting, and living (TAL) framework, that consists of critical, problem-solving, creativity, and metacognition. Besides, critical thinking includes the concept of analyzing information, applying strategies, ideas, logical inquiry,..., etc.; problem-solving is a basic process of identifying and choosing problems to be solved based on work understanding, brainstorming, choosing solutions, making plans, and creativity includes curiosity, fluency, originality, elaboration, imagination, and flexibility (Greenstein, 2012).

According to Fisher (2011), critical thinking is associated with any subject, content, or problem where the participants skillfully improve the quality of their thinking. Also, there are five parts of critical thinking skills; clarification, support, conclusions, further clarification, and strategy (Hudha & Batlolona, 2017; Duran & Dokme, 2016). Bakir & Ozetekin (2014) state that creativity is an important skill for prospective teachers. Because creativity is a process of experience, limitation of habits, new ways, and flexibility in solving problems.

The fourth thinking skill is metacognition. Metacognition includes two components, knowledge, and process-based learning (Yerdelen-Damar et al., 2015). In the classroom, aspects of metacognition are directed, forward-looking, conscious, self-regulated, and flexible (Greenstein, 2012). Also, metacognitive skills contribute to student learning outcomes (Bahri & Corebima, 2015). Thus, an explanation of thinking as 21<sup>st</sup> century skills was summarized in Table 1. Table 1 illustrated the conceptual of four of the thinking skills. These four skills are classified into a scale of 1-4, with details at level 1: emerging tier = 2.0 to 2.7 (beginning, novice, poor, serious error, incomplete); level 2: able tier = 2.8 to 3.1 (developing, basic, fair, some misconception, partial); level 3: skilled tier = 3.2 to 3.5 (accomplished,



professional, good, meets requirements, mostly complete; level 4: top tier = 3.6 to 4.0 (exemplary, advanced, excellent, goes beyond requirements, fully complete). Researchers have translated from English into Indonesian to be more easily understood by participants (Greenstein, 2012).

**Table 1.** The Four of Thinking Skill

Thinking skill	<b>Critical thinking</b>	Apply, evaluation, use of data, analysis, synthesis
	<b>Problem solving</b>	Identify the problem, applies problem solving, identifies solutions, evaluates solutions, defends solutions, applications, inductive and deductive reasoning
	<b>Creativity</b>	Curiosity, fluency, originality, elaboration, flexibility, divergents, messiness/risk taking
	<b>Metacognition</b>	Reflective, aware of thinking, strengths and style, using metacognition

## METHODS

This study employed a mixed-method with an explanatory sequential design (Creswell, 2016). The reason for choosing this design is because the perception of prospective biology

teachers is determined by quantitative findings followed by qualitative findings. Both findings are strengthened by a more comprehensive explanation. Thus, this study expects the study outcomes of deep understanding or a more in-depth understanding of quantitative data from prospective biology teachers. In this study, it involves a two-phase project in which the researcher collects quantitative data in the first phase, analyzes the results, and then uses the results to plan the second, qualitative phase. The quantitative results inform the types of participants to be purposefully selected for the qualitative phase and the types of questions that will be asked of the participants. The data collection proceeds in two distinct phases with intense quantitative sampling in the first phase and with purposeful sampling in the second, that is the qualitative phase. The quantitative and qualitative databases are analyzed separately in this approach. Finally, this design interprets the follow-up results in a discussion section of the study.

In the quantitative phase, this study utilized a descriptive survey. 168 (14 men and 154 women) of 195 PBTs participated in filling out the questionnaire. The goodness level of the research participants was 2.82 %. The questionnaire consisted of 24 statements of aspects of critical thinking, problem-solving, creativity, metacognition of the 21<sup>st</sup> century skill (Greenstein, 2012). The questionnaire has a rating scale of 1-4, and the four levels were broadly described in Table 2.

**Table 2.** Rubric Terminology of 21<sup>st</sup> century Skill

Level 4	Level 3	Level 2	Level 1
Top tier = 3.6 to 4.0	skilled tier = 3.2 to 3.5	able tier = 2.8 to 3.1	emerging tier = 2.0 to 2.7
Exemplary	Accomplished	Developing	Beginning
Advanced	Proficient	Basic	Novice
Excellent	Good	Fair	Poor
goes beyond requirements	meets requirements	some misconception	serious error
fully complete	mostly complete	Partial	Incomplete

To determine the validity of the instrument used the CFA Test. This test is often used to determine the quality of instruments and is considered a credible way by previous researchers such as Suhr (2018), Chai et al. (2015), Jia et al. (2016), and Sang et al. (2018). The Cronbach Alpha test was used to determine the reliability of the instrument. To determine the PBTs thinking skill profi-

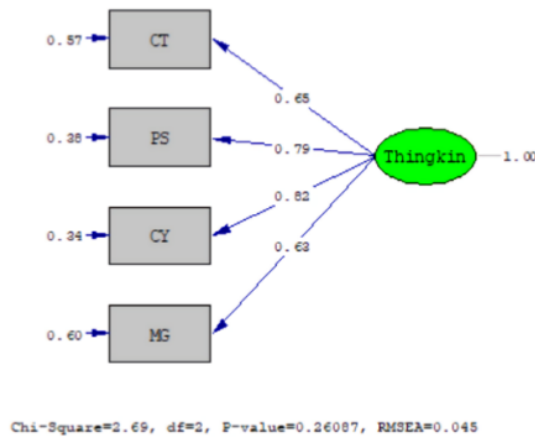
le in the form of average score and standard deviations, raw data were analyzed with descriptive statistics. PBT skill levels are displayed as a percentage. ANOVA test was used to determine differences in male and female PBTs thinking skills. And, the correlation test is used to determine the relationship between gender and thinking factors.

In the qualitative phase, in-depth interviews were conducted with 5 male PBTs and 7 female PBTs. According to Creswell (2016), the quantitative results inform the types of participants to be purposefully selected for the qualitative phase and the types of questions that will be asked of the participants. Based on this explanation, in this study, the number of participants used was following the research provisions. Interviews were conducted separately between one respondent and another respondent. Interview questions given to respondents were developed according to the questionnaire indicators in the quantitative test. Triangulation was conducted on the results of the interview. Steps such as verification, display and conclusion drawing from data are carried out to obtain or justify more valid and reliable information.

## RESULTS AND DISCUSSION

### CFA and Alpha Cronbach Test Results

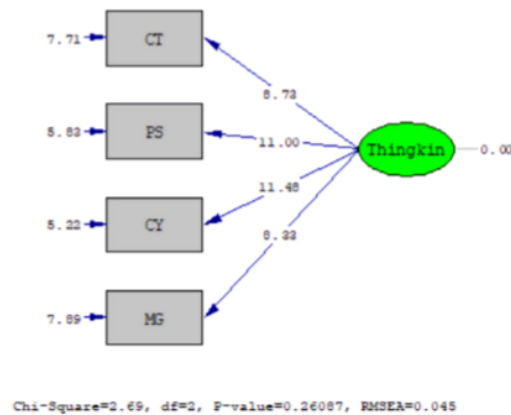
The CFA test results showed that the *Chi-Square* score = 2.69, *df* = 2, *P-value* = 0.26087 and *RMSEA* = 0.045. The reliability test results show that the *Cronbach's Alpha* score = .844 with *N of Items* = 24. Based on the pictures it can be concluded that all of the items (24 items) presented are valid because based on the image at the T-Value position there is no arrow from each indicator that was colored Red (see fig. 1 and fig. 2). This finding indicates that all items are valid. Besides, the results on the p-value of each item indicate that for all items the p-value is smaller than alpha divided by the number of items. The results of the p-value are all items smaller than alpha divided by the number of items, it can be concluded that all items measuring each indicator of thinking are valid.



**Figure 1.** Confirmatory Factor Analysis for Critical Thinking, Problem Solving, Creativity, Metacognition for Standardized Solution

Furthermore, in the fig. 1 Standardized Solution showed only one item or factor load whose number is less than 0.3. This finding indicates that points 2 to 24 can be said to be valid. Thus, the validity coefficient can be considered satisfactory if it exceeds 0.1 (Suhr, 2018). Furthermore, Suhr (2018) stated that CFA is a picture of the simplification of interrelated steps and the number of constructs and factor structures to determine the content or meaning of these factors. In

addition, the findings of this study are also in line with studies conducted by Jia et al. (2016). Regarding the use of Cronbach's alpha (1) a reliability test, Taber (2018) has said that (a) Cronbach's alpha is a statistic used by the writer to show that tests and scales that have been built or adapted for research projects, and (b) high alpha values provide limited evidence of the reliability of research instruments.



**Figure 2.** Confirmatory Factor Analysis for Critical Thinking, Problem Solving, Creativity, Metacognition for T-Value

#### Profile of Thinking Skill PBTs

Table 3 shows that the highest score for critical thinking was found at the exemplary level. The highest critical thinking score for male PBTs was 0.40%, and the highest critical thinking score

for female PBTs was 0.44%. Then, the lowest critical thinking score was found at the novice level. The lowest critical thinking score for male PBTs was 0.11%, and the lowest critical thinking score for female PBTs was 0.09%.

**Table 3.** Descriptive Statistics for the Profile of PBTs Thinking Skills

Thinking Skill	PBTs Skill Level (%)							
	Novice		Basic		Proficient		Exemplary	
	Male	Female	Male	Female	Male	Female	Male	Female
Critical thinking	0.11	0.09	0.16	0.16	0.33	0.21	0.40	0.44
Problem solving	0.07	0.06	0.25	0.30	0.38	0.34	0.24	0.23
Creativity	0.09	0.09	0.29	0.35	0.33	0.28	0.29	0.20
Metacognition	0.12	0.17	0.23	0.25	0.27	0.28	0.40	0.34
Total	0.39	0.41	0.93	1.06	1.31	1.11	1.33	1.21
Average	0.098	0.103	0.233	0.265	0.328	0.278	0.333	0.303
SD	0.022	0.047	0.054	0.081	0.045	0.053	0.081	0.11

The highest score for critical thinking was found at the exemplary level. The highest critical thinking score for male PBTs was 0.40%, and the highest critical thinking score for female PBTs was 0.44%. The lowest critical thinking score was found at the novice level. The lowest critical thinking score for male PBTs was 0.11%, and the lowest critical thinking score for female PBTs was 0.09%.

In contrast to critical thinking, the highest score for problem-solving was found at a proficient level. The highest problem-solving score for male PBTs was 0.38%, and the highest problem-solving score for female PBTs was 0.34%. The lo-

west score for problem-solving was found at the novice level. The lowest problem-solving score for male PBTs was 0.07%, and the lowest problem-solving score for female PBTs was 0.06%.

The study findings on creativity differ from both critical thinking and problem-solving. The highest score for creativity skills was found at different skill levels. The highest creativity score for male PBTs was 0.33%, which was found at the professional level. The highest creativity score for female PBTs was 0.35%, which is found at the basic level. The lowest creativity score was found at the novice level. The lowest creativity score for prospective male and female PBTs was 0.09.

In line with critical thinking, the highest score for metacognition was found at the exemplary level. The highest metacognition score for male PBTs was 0.40%, and the highest metacognition score for female PBTs was 0.34%. The lowest score for metacognition was found at the novice level. The lowest metacognition score for male PBTs was 0.12%. The lowest metacognition score for female PBTs was 0.17%.

The results of this study indicate that novice was the lowest skill level for the four types of skills e.g. critical thinking, problem-solving, creativity, and metacognition. The highest level for critical thinking and metacognition was found in exemplars, and the highest level for problem-solving and creativity was found in proficient, although the highest score of creativity for female biology teacher candidates was found at the basic level.

Interview results are in line with the results of descriptive statistical tests. PBTs answer questions that indicate that their critical thinking and metacognition skills are at a good level. The transcript of interviews with PBTs about the application of critical thinking skills in the learning process wrote in the following section.

1. *Researcher: In the aspect of applying critical thinking to the learning process, do you have a good understanding of the theories and facts related to the learning material?*  
*PBTs: I have a poor understanding of facts, principles and everything needed to help me understand the problem in learning.*
2. *Researcher: In the aspect of using analysis in the learning process, do you use it? How do you apply the analysis in the learning process?*  
*PBTs: With help, I can understand the problem directly and draw simple conclusions after being helped by others, especially by classmates. Sometimes I explain the main problems inaccurately. But I cannot contemplate it carefully in an objective way.*

The transcript of interviews with PBTs about the application of metacognition skills in the learning process wrote in the following section.

1. *Researcher: How do you reflect on your thinking of learning?*  
*PBTs: I need a visual or verbal structure to help me reflect on thoughts or with the help of others, I can improve thought reflection.*
2. *Researcher: Do you use metacognitive when studying? How do you do it?*  
*PBTs: I use my metacognitive abilities to improve my learning and productivity. I routinely apply it in daily practice.*

Also, PBTs answer questions that indicate that their problem-solving and creativity skills are at a less or enough level. The transcript of interviews with PBTs about the application of problem-solving skills in the learning process wrote in the following section.

1. *Researcher: Do you use analysis and synthesis in the learning process?*  
*PBTs: With the help of others, I can understand the problem directly and draw simple conclusions. But sometimes I explain the main problems inaccurately. But I cannot contemplate it carefully in an objective way. So as to combine and connect difficult ideas. So, I am less able to compile two different ideas, see a direct pattern, and summarize it.*
2. *Researcher: In the aspect of using evaluation in the learning process, do you have the ability to evaluate learning material?*  
*PBTs: The ability to evaluate objects, settings, or performance that I have is quite clear, especially related to the criteria or standards given by the lecturer in learning, so that I can use and understand the evaluation process accurately.*

The transcript of interviews with PBTs about the application of creativity skills in the learning process wrote in the following section.

1. *Researcher: How do you elaborate and focus on creativity while learning?*  
*PBTs: Maybe some ideas come to me if I'm working hard and usually I can find a way to make it better. I can do one or two but my idea is relatively simple. I can do two or three things with the process: merge, modify, adjust, or rearrange.*
2. *Researcher: Do you study and work when you do it with flexible creativity?*  
*PBTs: Sometimes it's hard for me to adjust to change. When someone reminds me to think differently, I can usually do it. So that I cannot work effectively even when things change and pay attention to the potential of some things when I study.*

### **The Difference in the Thinking Skills of Male and Female PBTs**

ANOVA has been conducted to differentiate thinking skills between male and female PBTs. Before, a homogeneity test was also carried out, and the results of the test of homogeneity of variances showed that the *Levene Statistics* score = .904, *df1* = 1; *df2* = 670 and *Sig.* = .342. So, it was concluded that found the similarity of variance and ANOVA test can be done. ANOVA test results showed on Table 4 that there are significant differences thinking skills of male and female PBTs (*F* score; 7157, *p* > 0.05). So, it was concluded that there were differences in thinking of male and female PBTs at Islamic universities.



**Table 4.** ANOVA Scores for Different of Thinking skills PBTs

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1505.194	1	1505.194	7.157	.008
Within Groups	140911.179	670	210.315		
Total	142416.373	671			

Furthermore, correlation tests carried out to determine the relationship and interaction between gender variables (male and female) with the type of thinking (critical thinking, problem sol-

ving, creativity, and metacognition). The correlation test data for gender variables with thinking factors showed on Table 5.

**Table 5.** Correlation for Gender and Factor of Thinking Skill

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	18011.475 <sup>a</sup>	7	2573.068	13.734	.000
Intercept	1028200.944	1	1028200.944	5487.930	.000
JK	1505.194	1	1505.194	8.034	.005
Indicator	1872.895	3	624.298	3.332	.019
JK * Indicator	1105.865	3	368.622	1.967	.118
Error	124404.898	664	187.357		
Total	3296276.283	672			
Corrected Total	142416.373	671			

a. R Squared = .126 (Adjusted R Squared = .117)

The study presented that there is no relationship between gender with the thinking skills factor. Because, the finding indicated that (a) There was a difference in the thinking skills of male and female PBTs ( $F=8.034$ ,  $P>0.05$ ); (b) There were differences in the ability of PBTs based on indicators ( $F=3.332$ , with a significance of 0.019); and (c) There was no interaction of gender with factors ( $F=1.967$ , with a significance of 0.118).

This study revealed that there was no relationship between gender and PBT skills. The findings of this study were coherent with research conducted by previous researchers in biology learning. Hadjichambis et al. (2016) found that gender is only a factor that will function as a mediator in learning about human reproduction. Furthermore, in the study of toxic and non-toxic plants, no differences were found in the identification skills of poisonous plants concerning age and sex (Prokop & Fančovičová, 2019). Špernjak & Šorgo (2018) have examined about testing differences in the knowledge gained and students' preferences for various technologies in biology laboratory work, and the results showed that there were no statistical differences related to the acquisition of student knowledge between these laboratory technologies concerning grades, gen-

der, or school score. And the level of education in learning biology also determine learning outcomes (Fonseca et al., 2012).

The study showed that PBTs gave their opinion about the need to increase mastery in problem-solving and creativity skills. On the other hand, for critical thinking and metacognition skills, PBTs gave the opinion that they already have good skills. This finding means that the applied integrative learning has not yet had an impact or has not targeted problem-solving and creativity skills for PBTs. On the other hand, integrative learning has targeted critical thinking and metacognition skills.

In this study, problem solving and creativity were less mastered competencies but it is important to be taught to prospective biology teacher students. Both of these skills involve the process of: (a) describing problems with depth and clarity; (b) looking at problems with an open mind, evaluating alternatives, and considering various perspectives; (c) gathering information to make informed choices and developing plans; (d) applying and monitor with integrity, and (e) evaluating the results and being willing to review the problem (Greenstein, 2012). Furthermore, this study also shows that students' problem-solving skills increase when applying problem-based learning (Argaw et al., 2016).

In this study, four skills reviewed and consulted with the PBTs. These findings are in line with the results of studies conducted by Afandi et al. (2019). The study revealed that there are four competencies in The Indonesian Partnerships of

21<sup>st</sup> century Skills (IP-21CS) for prospective science teacher students: (1) 4Cs (critical thinking, creative thinking, collaboration, and communication); (2) ICTs (technology, media, and information literacy); (3) spiritual values (religious beliefs and spiritual awareness), and (4) character building (teachers' attitude and scientific attitudes).

This study has implications that prospective biology teachers in Islamic universities need to master 21<sup>st</sup> century skills, namely critical thinking, problem-solving, creativity, and metacognition. They need to understand that learning in class requires a learning environment that includes critical thinking, problem-solving, creativity, and metacognition. Teachers and learning managers also need to understand that the learning they manage must contain critical thinking, problem-solving, creativity, and metacognition.

### CONCLUSION

The findings of this study indicated that; (a) Most male and female PBTs at Islamic universities have high skills in critical thinking and metacognition; (b) Most male and female PBTs at Islamic universities have insufficient skills in problem-solving and creativity skills; (c) This study presents that there is no relationship between gender and PBT skills.

The results of this study can be used as criticism for educational management majors in biology education in Indonesia, especially at Islamic Universities. Educational managers need to pay attention that the application of integrative learning needs to pay attention to the skills required by PBTs. Learning applied in classrooms must be based on 21<sup>st</sup> century skills.

### ACKNOWLEDGEMENTS

This work was supported by IAIN Batu-sangkar (grant numbers B-870.a/ln.27/R.IV/TL.00/04/2019).

### REFERENCES

- Afandi, A., Sajidan, S., Akhyar, M., & Suryani, N. (2019). Development Frameworks of the Indonesian Partnership 21st-Century Skills Standards for Prospective Science Teachers: A Delphi Study. *Jurnal Pendidikan IPA Indonesia*, 8(1), 89-100.
- Agyei, D. D., & Voogt, J. M. (2015). Pre-service teachers' TPACK competencies for spreadsheet integration: insights from a mathematics-specific instructional technology course. *Technology, Pedagogy and Education*, 24(5), 605-625.
- Alfarhan, U. F., & Daultova, V. (2019). Revisiting the gender academic achievement gap: evidence from a unique environment. *Gender and Education*, 31(7), 827-848.
- Argaw, A. S., Haile, B. B., Ayalew, B. T., & Kuma, S. G. (2016). The effect of problem based learning (PBL) instruction on students' motivation and problem solving skills of physics. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(3), 857-871.
- Ashraf, K. A. (2018). The relationship between Jordanian students' 21st century skills (Cs21) and academic achievement in science. *Journal of Turkish Science Education*, 15(2), 82-94.
- Aslan, A., & Zhu, C. (2017). Investigating variables predicting Turkish pre-service teachers' integration of ICT into teaching practices. *British Journal of Educational Technology*, 48(2), 552-570.
- Bahri, A., & Corebima, A. D. (2015). The contribution of learning motivation and metacognitive skill on cognitive learning outcome of students within different learning strategies. *Journal of Baltic Science Education*, 14(4), 487-500.
- Bakır, S., & Öztekin, E. (2014). Creative thinking levels of preservice science teachers in terms of different variables. *Journal of Baltic Science Education*, 13(2), 231-242.
- Chai, C. S., Deng, F., Tsai, P. S., Koh, J. H. L., & Tsai, C. C. (2015). Assessing multidimensional students' perceptions of twenty-first-century learning practices. *Asia Pacific Education Review*, 16(3), 389-398.
- Chang, P. S., Lee, S. H., & Wen, M. L. (2020). Metacognitive inquiry activities for instructing the central dogma concept: 'button code' and 'beaded bracelet making'. *Journal of Biological Education*, 54(1), 47-62.
- Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.
- Drake, S. M., & Reid, J. L. (2018). Integrated curriculum as an effective way to teach 21st century capabilities. *Asia Pacific Journal of Educational Research*, 1(1), 31-50.
- Duran, M., & Dökme, İ. (2016). The effect of the inquiry-based learning approach on student's critical-thinking
- Fisher, A. (2011). *Critical thinking: An introduction*. Cambridge University Press.
- Fitriani, H., Asy'ari, M., Zubaidah, S., & Mahanal, S. (2019). Exploring the Prospective Teachers' Critical Thinking and Critical Analysis

- Skills. *Jurnal Pendidikan IPA Indonesia*, 8(3), 379-390.
- Fonseca, M. J., Costa, P., Lencastre, L., & Tavares, F. (2012). Multidimensional analysis of high-school students' perceptions about biotechnology. *Journal of Biological Education*, 46(3), 129-139.
- Geisinger, K. F. (2016). 21st century skills: What are they and how do we assess them?. *Applied Measurement in Education*, 29(4), 245-249.
- Greenstein, L. M. (2012). *Assessing 21st century skills: A guide to evaluating mastery and authentic learning*. Corwin Press.
- Greiff, S., & Kyllonen, P. (2016). Contemporary assessment challenges: the measurement of 21st century skills. *Applied Measurement in Education*, 29(4), 243-244.
- Hadjichambis, A. C., Georgiou, Y., Paraskeva-Hadjichambi, D., Kyza, E. A., & Mappouras, D. (2016). Investigating the effectiveness of an inquiry-based intervention on human reproduction in relation to students' gender, prior knowledge and motivation for learning in biology. *Journal of Biological Education*, 50(3), 261-274.
- Haviz, M. (2016). Designing and developing the integrated learning model on embryology. *Transylvanian Review*, (4), 1043-1052.
- Haviz, M., Karomah, H., Delfita, R., Umar, M. I. A., & Maris, I. M. (2018). Revisiting generic science skills as 21st century skills on biology learning. *Jurnal Pendidikan IPA Indonesia*, 7(3), 355-363.
- Haviz, M., Lufri, L., Fauzan, A., & Effendi, Z. M. (2016). Model Pembelajaran Integratif Pada Biologi Perkembangan Hewan: Analisis Kebutuhan Pengembangan. *Ta'dib*, 15(1), 1-14.
- Holland, D. D., & Piper, R. T. (2014). A technology integration education (TIE) model: Millennial preservice teachers' motivations about technological, pedagogical, and content knowledge (TPACK) competencies. *Journal of Educational Computing Research*, 51(3), 257-294.
- Hudha, M. N., & Batlolona, J. R. (2017). How are the physics critical thinking skills of the students taught by using inquiry-discovery through empirical and theoretical overview?. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(2), 691-697.
- Jia, Y., Oh, Y. J., Sibuma, B., LaBanca, F., & Lorentson, M. (2016). Measuring twenty-first century skills: development and validation of a scale for in-service and pre-service teachers. *Teacher Development*, 20(2), 229-252.
- Larson, L. C., & Miller, T. N. (2011). 21st century skills: Prepare students for the future. *Kappa Delta Pi Record*, 47(3), 121-123.
- Listiana, L., Susilo, H., Suwono, H., & Suarsini, E. (2016). Empowering students' metacognitive skills through new teaching strategy (group investigation integrated with think talk write) in biology classroom. *Journal of Baltic Science Education*, 15(3), 391.
- Lucas, B. (2016). A five-dimensional model of creativity and its assessment in schools. *Applied Measurement in Education*, 29(4), 278-290.
- Maryuningsih, Y., Hidayat, T., Riandi, R., & Rustaman, N. Y. (2019, February). Critical thinking skills of prospective biology teacher on the chromosomal basic of inheritance learning through online discussion forums. In *Journal of Physics: Conference Series* (Vol. 1157, No. 2, p. 022090). IOP Publishing.
- Nawani, J., von Kotzebue, L., Spangler, M., & Neuhaus, B. J. (2019). Engaging students in constructing scientific explanations in biology classrooms: a lesson-design model. *Journal of Biological Education*, 53(4), 378-389.
- Pedersen, J. M. (2019). Gender Achievement Gaps: Re-examining the Transformational Debate. *Childhood Education*, 95(5), 74-78.
- Prokop, P., & Fančovičová, J. (2019). The perception of toxic and non-toxic plants by children and adolescents with regard to gender: implications for teaching botany. *Journal of Biological Education*, 53(4), 463-473.
- Sang, G., Liang, J. C., Chai, C. S., Dong, Y., & Tsai, C. C. (2018). Teachers' actual and preferred perceptions of twenty-first century learning competencies: a Chinese perspective. *Asia Pacific Education Review*, 19(3), 307-317.
- Sladek, R. M., Bond, M. J., & Phillips, P. A. (2010). Age and gender differences in preferences for rational and experiential thinking. *Personality and Individual Differences*, 49(8), 907-911.
- Sondergeld, T. A., & Johnson, C. C. (2019). Development and validation of a 21st century Skills Assessment: Using an iterative multimethod approach. *School Science and Mathematics*, 119(6), 312-326.
- Špernjak, A., & Šorgo, A. (2018). Differences in acquired knowledge and attitudes achieved with traditional, computer-supported and virtual laboratory biology laboratory exercises. *Journal of Biological Education*, 52(2), 206-220.
- Suhr, D. D. (2018). Exploratory of confirmatory factor analysis? Statistics and data analysis. Paper 200-31.
- Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48(6), 1273-1296.
- Teo, P. (2019). Teaching for the 21st century: A case for dialogic pedagogy. *Learning, Culture and Social Interaction*, 21, 170-178.
- Wang, Y., Lavonen, J., & Tirri, K. (2018). Aims for learning 21st century competencies in national primary science curricula in China and Finland. *EURASIA Journal of Mathematics, Science and Technology Education*, 14(6), 2081-2095.
- Warren, F., Mason-Apps, E., Hoskins, S., Azmi, Z., & Boyce, J. (2018). The role of implicit theories,

- age, and gender in the creative performance of children and adults. *Thinking Skills and Creativity*, 28, 98-109.
- Yerdelen-Damar, S., Özdemir, Ö. F., & Ünal, C. (2015). Pre-service Physics Teachers' Metacognitive Knowledge about Their Instructional Practices. *Eurasia Journal of Mathematics, Science & Technology Education*, 11(5).
- Zainuddin, Z., & Attaran, M. (2016). Malaysian students' perceptions of flipped classroom: A case study. *Innovations in Education and Teaching International*, 53(6), 660-670.
- Zainuddin, Z., & Perera, C. J. (2019). Exploring students' competence, autonomy and relatedness in the flipped classroom pedagogical model. *Journal of Further and Higher Education*, 43(1), 115-126.



# Assesing PBTs (Final to JPll)

## ORIGINALITY REPORT

2%

SIMILARITY INDEX

%

INTERNET SOURCES

%

PUBLICATIONS

%

STUDENT PAPERS

## PRIMARY SOURCES

1

Submitted to Universiti Kebangsaan Malaysia

Student Paper

2%

Exclude quotes Off

Exclude bibliography On

Exclude matches < 2%