

# Assessing Pre-Service Teachers' Perception on 21st century Skills in Indonesia

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# Assessing Pre-Service Teachers' Perception on 21<sup>st</sup> century Skills in Indonesia

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## ABSTRACT

This study was done to assess pre-service teachers' perception of thinking, acting and living (TAL) from 21st century skills. The participants who have filled out this questionnaire are 321 pre-service teachers, consisting of 38 men and 283 women from a population of 403 pre-service teachers of mathematics, biology, physics and chemistry. The significance level of the research participants was in the range of 3.70 - 5.40%. The questionnaire consisted of aspects of thinking, acting and living (TAL) of the 21<sup>st</sup> century skills, and it included 16 indicators and 78 statements. The quality of the instrument was achieved by the use of confirmatory factor analysis (CFA) and Cronbach's alpha tests. The result of validity with CFA indicates that the highest score is found in living ( $\chi^2=676.71$ ), followed by thinking ( $\chi^2=479.55$ ) and acting ( $\chi^2=479.55$ ), and *Cronbach's Alpha* = .940, *N items*=78. This study used the multiple comparisons with Tukey HSD and LSD test for factors of the 21st century skills. The results show that the quality of instrument to be valid and reliable. The TAL profile of the pre-service teachers was at the level of able tier, there is a different score of TAL for pre-service teachers, and there is an effect of gender and department for TAL. The other findings indicate that the level of TAL for pre-service teacher in mathematics is related to physics, and biology is related to chemistry. Finally, this study confirms the use of appropriate learning methods to bring 21st century skills to pre-service teachers in mathematics, biology, physics and chemistry.

**Keywords** Pre-service teacher, 21st century skill, thinking acting and living, mathematics, biology, physics, chemistry

## INTRODUCTION

In the last decade, the assessment of 21st century skills have been one of the "hottest" topics in the education (Geisinger, 2016). The term 21st century skills has been developed as a key concept and slogan in the field of education (Greiff & Kyllonen, 2016). Because these skills are needed by students to prepare themselves for life in the future (Larson & Miller, 2011), or after graduation (Kaufman, 2013). Including of aims for learning 21st century skills in curricula has been also an important issue worldwide (Wang, Lavonen, & Tirri, 2018). Among the types of 21st century skills needed by students, are collaborative problem solving, complex problem solving, creativity, and digital information literacy (Geisinger, 2016). Some other 21st century skills include reasoning, collaboration, and self-regulation (Ahonen & Kinnunen, 2015), creativity (Lucas, 2016), computer and information literacy (Ainley, Fraillon, Schulz, & Gebhardt, 2016).

There are relationships between several fields that become competencies for students with the process of learning (Greenstein, 2012). The 21st century learning process must involve students in learning-to-learn and collaborating-to-learn to promote thinking processes such as critical thinking, creative thinking, and authentic problem-solving (Chai, Deng, Tsai, & Koh, 2015). Other 21st century skills are raised in learning are life and career skills, learning and innovation skills, and information media and technology skills (Trilling & Fadel, 2009). In addition, the 21st century skills are also included in curriculum development (Tunnicliffe, 2007; Burden & Hall, 2005; Rowland, 2007). The 21st century skills have also been used in learning process at higher education (Williams, 2005; Tritschler, 2008), such as preparation ICT for pre-service teachers (Lambert & Gong, 2010; Fry & Seely, 2011), and learning evaluation of 21st century learning (DiCerbo, 2014).

There are articles was studies done to investigate the types and factors of 21st century skills in learning process, and to develop the instruments of 21st century skills. Chai, Deng, Tsai, & Koh (2015) conducted a multidimensional study on students' perceptions of 21st century learning practices and found that the validation of the survey yielded satisfactory reliability and validity through both exploratory and confirmatory factor analyses. The results also showed that the subscales that survey students' perceptions of critical thinking, creative thinking, and authentic problem-solving were more dominant predictors of their knowledge creation efficacy as compared to their perceptions about the learning processes. Muhammad & Osman (2010) used a survey method study to compare students' scientific thinking skills in Malaysia and Bruney, and found that the dimension of inventive thinking skills is comprised of adaptability and managing complexity, self direction, curiosity, creativity, risk taking and higher order thinking and sound reasoning. Jia, Oh, Sibuma, LaBanca, & Lorentson (2016) developed the instrument to assess the 21st century skills for pre-service students and found that the analysis identified a three dimensional scale including innovation and problem solving, collaboration, and utility of technology for pre-service teachers and a one-dimension scale, cross-functional skills, for in-service teachers. Ercikan & Oliveri (2016) discussed about research on assessing 21st century skills and found that taking construct of assessment, cognitive validity evidence and cross-cultural validity that need to be addressed explicitly in assessments of complex constructs such as those captured under the 21st century skills/constructs label. Sang, Liang, Chai, Dong, & Tsai (2018) conducted a study about actual and preferred perceptions of twenty-first century learning competencies of teachers and the results indicated that there was a clear gap between actual and preferred perceptions of 21st century learning.

In the last decade, studies focused on investigating the use of learning strategies and determining the factors of 21st century skill in mathematics and science. Kan'an (2018) investigated the relationship between Jordanian students' 21st century skills and academic achievement levels in science and found that that urban and female students were better in acquiring the 21st century skills than rural and male students. Tokmak, Incikabi, & Oztgelen (2012) investigated the effect of technological, pedagogical, content knowledge (TPACK)-based course design on mathematics, science, and literacy education of pre-service teachers TPACK and found that there were no significant differences between natural sciences (mathematics and science education) and social sciences (literacy) for pre-service teachers' TPACK. Bell (2010) investigated the use of project-based learning for the future skill in 21st century and found that the students drive their own learning through inquiry, as well as work collaboratively to do research and create projects that reflect their knowledge. Duran, Yaussy, & Yaussy (2011) has investigated the integration of 21st century skills into science teaching and found that the meaningful and enjoyable student collaboration, the upbeat class environment, and the enhanced student engagement achieved at the conclusion of this challenging activity set an optimal teaching and learning environment for the entire

quarter/semester. Haviz, Karomah, Delfita, Umar, & Maris (2018) has examined the generic science skill as a 21st century skill and found that the students' generic science skills were considered to be part of 21st-century skills. There are other influential factors, such as gender, the type of skill that is more comprehensive, and the department where the students study. But this subject requires further study, for example conducting a research on the assessment of student perceptions of the 21st century skills. Although in reality, few studies are found about students' perceptions or views of what 21st century skills they think they need, especially the lack of studies about the assessment of student perceptions of the 21st century skills in class of mathematics and science seems clear.

### **Thinking, Acting and Living as 21st Century Skill Competencies**

The terminology of thinking is the term of variable make individuals to develop problem-solving skills, focusing on the importance of thinking in terms of variables (Unver, 2015). According to Greenstein (2012), thinking skills are differentiated into critical, problem solving, creativity and metacognition. Critical thinking is the mode of thinking about any subject, content, or problem (Elder, 2007). There are several articles investigated about critical thinking, for example the research conducted by Wartono, Hudha, & Batlolona (2018). The study showed that there are 5 elements of the critical thinking skills for senior high school students; elementary clarification, basic support, inference, advanced clarification, and strategies and tactics. In other study showed that analysis, evaluation, inference, interpretation, explanation, and self-organization sections was used to determine students' critical thinking skills (Duran & Dökme 2016).

Problem solving is the basics process for identifying problems, considering options and making informed choices, and the step in problem solving are understand the problem, brainstorm all possible solutions, devise a plan, carry out the plan and evaluate the result (Greenstein, 2012). In other study showed that the effectiveness of the thinking strategy and visual representation approach in increasing students' achievement, conceptual knowledge, metacognitive, problem-solving strategies, and attitudes toward mathematical word problem solving among primary school students (Abdullah, Halim, & Zakaria, 2014). The students' quantitative problem-solving skills was also improved in problem-based learning environment (Argaw, Haile, Ayalew, & Kuma, 2017).

Similarly, the creativity becomes important for pre-service teachers (Bakır & Öztekin, 2014). Because creativity is a process related to experiences, the restriction of habits, new concepts in some problems and the abilities to solve the problems (Bélanger, Akre, Berchtold, & Michaud, 2011). In the study conducted by Sener & Tas (2017), it was shown that there is a significant difference between the scores of the creativity and creative thinking scores of experimental and control groups when compared before and after teaching process.

Metacognition includes the components and process base of knowledge (Damar, Özdemir, & Unal, 2015). The level of students' metacognitive skills improved after a study integrated with think talk write teaching strategy (Listiana, Susilo, Suwono, & Suarsini, 2016), and metacognitive skills contributed to cognitive learning outcome was much greater than the contribution of learning motivation (Bahri & Corebima 2015).

The acting and living skills are different. According to Greenstein (2012), acting skill was divided in to communication, collaboration, digital literacy, visual literacy and technology literacy. Common Core State Standards Initiative (2011) stated that the communication skills have been identified in practice education, such as identifying and using a variety of types of verbal communication such as conversation, debate, and persuasion, etc. Living of 21st century skills includes to citizenship, global, leaderships and responsibility, college, and career/workplace. Global definitions refer to the attitudes and principles that make it possible to interact with people from around the globe in ways that are intentionally peaceful, respectful,

and productive. Leaderships and responsibility include the terms visionary, relationships building, knowledgeable, collaborative, and tactical. College and career/workplace skills are related to college ready academic skills, abilities, and attributes to be prepare for any post-secondary education (Greenstein, 2012).

### Aim and Research Question

Greenstein (2012) divides the 21st century skill into three groups which include the learning processes namely thinking, acting and living (TAL). Learning in higher education in Indonesia should refer to and apply the Indonesian national qualification framework and this framework requires students to master certain level of competences (Haviz, 2018a; Haviz, 2018b). For example, based on Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 73 year 2013, the undergraduate level has to master 6th and 7th levels. This regulation also mandates learning outcomes to include capabilities acquired through the internalization of knowledge, attitudes, skills, competencies, and accumulated work experience. Indonesian national qualification framework includes the 21st century skills, that has been written on this regulation. This research conduct developing TAL's instrument, investigated the profile of TAL and the relationships among the factors of 21st century skills. Therefore, the aim of the study to assess pre-service teachers' perception of TAL in 21st century skills. The research questions were as follows:

- RQ1: What is the quality of TAL's instrument in 21st century skills for pre-service teachers in mathematics, biology, physics, chemistry?
- RQ2: What is the profile of TAL in 21st century skills for pre-service teachers in mathematics, biology, physics, chemistry?
- RQ3: What is relationships among the factors of 21st century skill?

## METHODS

### Participants

This research involved pre-service teachers in mathematics, biology, physics and chemistry in faculty of science education IAIN Batusangkar, Indonesia. The participants who have filled out this questionnaire were 321 pre-service teachers, consisting of 38 male and 283 female chosers from a population of 403 pre-service teachers. The significance level of the research participants was in the range of 3.70 - 5.40%. The number of participants in mathematics education was 106 people, and only 92 pre-service teachers (Male=15 and Female=77) have completed the questionnaire. So, that the the significance level score was 3.73%. The number of participants in biology education were 195 pre-service teachers, and only 137 pre-service teachers (Male=14 and Female=123) have completed the questionnaire. So, the The significance level score was 4.57%. The number of participants in physics education were 59 pre-service teachers, and only 53 pre-service teachers (Male=8 and Female=45) have completed the questionnaire. So that the goodness level score was 3.987%. The number of participants in the chemistry education was 44 pre-service teachers and only 39 pre-service teachers (Male=1 and Female=38) who completed the questionnaire. So, that the the significance level score was 5.35%. The summary of the participants was summarized in Table 1.

**Table 1** Summary of research participants of 21st century skill

Departments	N	Sample			Goodness level (%)
		Male	Female	Total	
Mathematic	106	15	77	92	3.73

Biology	195	14	123	137	4.57
Physics	58	8	45	53	3.98
Chemistry	44	1	38	39	5.35
Total	403	38	283	321	

The questionnaire consisted of aspects of thinking, acting and living (TAL) of the 21<sup>st</sup> century skills, and it included 16 indicators and 78 statements (Greenstein, 2012). Thinking consisted of critical thinking (CritT), problem solving (PS), creativity (Creat), metacognition (Metacog). Acting consisted of communicating (Comm), debate (Deb), collaborating (Col), digital literacy (DL), technology literacy (TL). Living involved civics and citizenship (CC), global (Glob), leaderships and responsibility (LR), work ethic (WE), college/career/workplace (CCW), flexibility/adaptability (FA), initiative/motivation (IM). This questionnaire is Likert type with 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, proficient, 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).

### Data Collection and Analysis

This research was conducted by a survey design. A survey design provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population (Gay, Mills, & Airasian, 2009). In this research, thinking, acting, and living (TAL) skills were chosen as independent variables, while gender and department was as dependent variables.

The TAL's instrument was filled by pre-service teachers in accordance with the results of the sample calculation given in Table 1. The quality of the instrument was checked by the use of confirmatory factor analysis (CFA) and Cronbach's Alpha. These tests were taken as both are considered to be credible ways to conduct instrument validation (Suhr, 2018; Chai, Deng, Tsai, & Koh, 2015; Jia, Oh, Sibuma, LaBanca, & Lorentson, 2016; Sang, Liang, Chai, Dong, & Tsai, 2018). For instrument reliability, Cronbach's Alpha test was employed. The result of validation and reliability is thought to determine the quality of the instrument. Furthermore, this analysis used in refer to the survey technique analysis was as described by Creswell (2014). In the step of analyzing the data, the reports include the number of sample group member surveyed and those not surveyed, a table of the number of respondents and the percentage, discussion of the bias of respondents and their influence on research and the multiple comparisons made with Tukey HSD and LSD test for factor of the 21<sup>st</sup> century skills. The calculation of the data was conducted by using descriptive and inferential statistics with the *SPSS 21 for Windows*.

## RESULTS

### The Quality of TAL's Instrument in 21st Century Skill for Pre-service Teachers

Pattern/structure coefficients for thinking, acting and living instrument with CFA test was summarized on Tables 2, 3 and 4. Table 1 shows that score for each item was in the range of 0.6 – 0.9. The result of validity with CFA indicates that the highest score is found in living ( $\chi^2=676.71$ ), followed by thinking ( $\chi^2=479.55$ ) and acting ( $\chi^2=479.55$ ). The score of *Root Mean Square Error of Approximation* on each factor were respectively as thinking ( $RMSEA=0.055$ ), acting ( $RMSEA=0.047$ ) and living ( $RMSEA=0.047$ ). This RMSEA value shows that this instrument model was accepted, because RMSEA value was in the range of values 0-1 (Hu and Bentler, 1999). As noted in Table 5, pre-service teachers in mathematics,

biology, physics, chemistry have the highest mean score of 21st century skills, as in living ( $M=72.22$ ), then followed by thinking ( $M=66.94$ ), and acting ( $M=65.12$ ). This result shows that this instrument was valid. The Cronbach's alpha test results listed in Table 5 also indicates that this instrument was reliable (*Cronbach's Alpha = .940, N items=78*).

**Table 2** Pattern/structure coefficients for thinking

Item	Factor 1	Factor 2	Factor 3	Factor 4
CritT1	0.97			
CritT2	0.84			
CritT3	0.81			
CritT4	0.87			
CritT5	0.90			
PS1		0.81		
PS2		8.83		
PS3		0.73		
PS4		0.76		
PS5		0.78		
PS6		0.81		
PS7		0.84		
PS8		0.64		
Creat1			0.67	
Creat2			0.84	
Creat3			0.87	
Creat4			0.79	
Creat5			0.82	
Creat6			0.79	
Creat7			0.82	
MetaCog1				0.86
MetaCog2				0.82
MetaCog3				0.78
MetaCog4				0.76

**Table 3** Pattern/structure coefficients for acting

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Comm1	0.84				
Comm2	0.73				
Comm3	0.73				
Comm4	0.88				
Deb1		0.58			
Deb2		0.87			
Deb3		0.64			
Deb4		0.77			
Deb5		0.67			
Deb6		0.83			
Col1			0.78		
Col2			0.80		
Col3			0.64		
Col4			0.75		
DL1				0.70	
DL2				0.77	
DL3				0.84	
DL4				0.88	
TL1					0.71
TL2					0.64
TL3					0.97
TL4					0.74
TL5					0.72

**Table 4** Pattern/structure coefficients for living

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
CC1	0.94						
CC2	0.80						
CC3	0.74						
Glob1		0.79					
Glob2		0.85					
Glob3		0.52					
Glob4		0.58					
Glob5		0.68					
LR1			0.87				
LR2			0.79				
LR3			0.79				
WE1				0.75			
WE2				0.69			
WE3				0.92			
WE4				0.65			
WE5				0.78			
WE6				0.63			
WE7				0.74			
CCW1					0.71		
CCW2					0.71		
CCW3					0.71		
CCW4					0.66		
CCW5					0.64		
FA1						0.71	
FA2						0.87	
FA3						0.56	
IM1							0.71
IM2							0.87
IM3							0.64
IM4							0.62

**Table 5** Goodness of fit indicators for factor solutions and Cronbach's Alpha for item of instrument

Factor	N	Mean	SD	$\chi^2$	df	$\chi^2/df$	RMSEA	N item	Cronbach's Alpha
Thinking	321	66.94	10.16	479.55	242	0.00000	0.055		
Acting	321	65.12	9.62	416.30	243	0.00000	0.047	78	.940
Living	321	72.33	10.58	676.71	398	0.00000	0.047		

### Investigating the Profile of TAL for Pre-service Teachers

The profile of 21st century skill for pre-service teachers in mathematics, biology, physics, chemistry shows that the living's score for pre-service teachers was higher than the thinking's and acting's scores (see Table 6). This finding indicates that the skills of pre-service teachers in mathematics, biology, physics, chemistry was at the level 2 (able tier). Then, the result of multiple comparisons with Tukey HSD and LSD test for factor department was showed that there was significant different score 21st century skill for pre-service teacher in mathematics, biology, physics, chemistry. Then, the multiple comparison with Tukey HSD were conducted to investigated the differences of 21st century skill in each department, and showed that, there was a significant difference between 21st century skill for each department in mathematics, biology, physics, chemistry. Based on this explanation, it can be concluded that the level of

21st century skills of pre-service teachers in mathematics was in relation with physics, and biology was in relation with chemistry.

**Table 6** Profile of thinking, acting and living for pre-service teachers of mathematics, biology, physics, chemistry

Department	Skill	M ± SD
Mathematics (N=92)	Thinking	63.19 ± 8.19
	Acting	63.19 ± 7.54
	Living	70.42 ± 8.82
	Total	65.60 ± 8.85 <sup>a,b **</sup>
Biology (N=137)	Thinking	69.73 ± 10.46
	Acting	66.90 ± 9.78
	Living	73.71 ± 11.23
	Total	70.11 ± 11.25 <sup>a,b *</sup>
Physics (N=49)	Thinking	64.17 ± 10.08
	Acting	63.68 ± 9.84
	Living	70.97 ± 11.14
	Total	66.27 ± 10.82 <sup>a,b **</sup>
Chemistry (N=43)	Thinking	69.23 ± 9.97
	Acting	65.18 ± 11.82
	Living	72.79 ± 10.81
	Total	69.07 ± 11.25 <sup>a,b *</sup>
Total (N=321)	Thinking	66.94 ± 10.15
	Acting	65.12 ± 9.61
	Living	72.22 ± 10.58

<sup>a, b</sup> The mean difference is significant with LSD and HSD test at the .05 level

\* The Means for groups in homogeneous with HSD test at the .05 level

\*\* The Means for groups in homogeneous with HSD test at the .05 level

The result about the gap in profile of thinking, acting, and living for male and female for pre-service teachers was shown in Table 7. This finding shows that there was no significant difference ( $p > 0.05$ ;  $0.468 < P\text{-value} < 0.640$ ) between the profile of 21st century skill between male and female participants.

**Table 7** Gap in profile of thinking, acting and living for male and female for pre-service teachers

Gender	N	M ± SD	SE Mean	Levene's Test	t-Test
Male	38	68.76 ± 8.94	1.45005	.044 < .834	.468 < .640
Female	282	68.04 ± 8.86	.52745		

Levene's Test for Equality of Variances (0.05) and t-Test for Equality of Means (0.05)

The result about the gap in profile between thinking, acting, and living for pre-service teachers was presented in Table 8. These results of multiple comparisons with LSD was showed that there were significant differences in mean factor scores at the level of 0.05. For example, the mean gap between thinking and acting is found to be 1.8300. This result was a significance value of .023 at  $p > 0.05$ . Based on these explanations, it is concluded that: (a) there was a significant difference between score of thinking, acting and living for pre-service teachers in MBFC; (b) there was no relation between gender and TAL and (c) the contribution of gender to TAL was 8%.

**Table 8** Gap in profile between thinking, acting, and living for pre-service teachers

Main Skill	Subskill	Mean Difference
Thinking	Acting	1.8300*
	Living	-5.2596*

Acting	Thinking	-1.8300*
	Living	-7.0896*
Living	Thinking	5.2596*
	Acting	7.0896*

Based on observed means. The error term is Mean Square (Error) = 102.695.  
\* The mean difference is significant at the .05 level.

### Relationships among the Factors of 21st Century skill

The result of the study about gap between factor factors of 21st century skill suggests that the dependent test score for thinking, acting and living between gender was the F corrected model score was  $17.295 > .000$ , and the value of  $R$  squared=.083 and adjusted  $R$  squared=.078 (see table 9). The data in Table 9 also shows that the dependent test score for thinking, acting, and living between departments were the F corrected model score ( $12.224 > (.000)$ ), and the value of  $R$  squared=.124 and adjusted  $R$  squared=.114. This result indicates that the contribution of gender and department were 12.4%. These findings indicated that no relation is found between thinking, acting and living with gender, and there are no relations between thinking, acting and living with department. But the findings also indicated that there is a difference between 21st century skills of pre-service teachers of mathematics, biology, physics, chemistry.

**Table 9** Gap between factor factors of 21st century skill

Factor	Type III Sum of Squares	R Squared	Adjusted R Squared	F
TAL vs Gender	8880.562	.083	.078	17.295
TAL vs Department	13281.488	.124	.114	12.224

## DISCUSSION

At the measurement of the quality of instrument, the use of the CFA test has shown that the construction of the factors in the instrument has been identified. Confirmatory factor analysis (CFA) described as orderly simplification of interrelated measures and the number of constructs and the underlying factor structure are identified (Suhr, 2018). Suhr (2018) also stated, the goals of factors are to help the investigator to determine the number of latent constructs, to provide a few newly created variables (factors), and define the content or meaning of factors. This result was also supported by other findings. Mahat, Hashim, Nayan, Saleh & Norkhaidi (2018) conducted a confirmatory factor analysis of Malaysian primary school students' energy saving practices, and found that the Cronbach's alpha value, which was higher than 0.70, was high and acceptable. Jia, Oh, Sibuma, LaBanca, & Lorentson (2016) was found that the validity and reliability of EFA and CFA was conducted in 16 subjects: information literacy, collaboration, communication, innovation and creativity, problem solving, and responsible citizenship. In line with this study, Taber (2017) has recommended the use of Cronbach's alpha when developing and reporting research instruments in science education, and also stated (a) Cronbach's alpha is a statistic commonly quoted by authors to demonstrate that tests and scales that have been constructed or adopted for research projects are fit for purpose, and (b) a high value of alpha offers limited evidence of the reliability of a research instrument, and that indeed a very high value may actually be undesirable when developing a test of scientific knowledge or understanding.

2 At the 21st century skill level mastery, this study was found that 21st century skills of pre-service teachers in mathematics, biology, physics, chemistry were at level 2. According to Geinsteiner (2012), the conversions of level 2 (able tier=2.8-3.1) are likely to be developing, basic, fair, some misconception and partial. The findings of this study showed that students need an increase in 21st century skills in the process of learning. Because, to help students

build twenty-first century learning skills, teachers must have reasonable perceptions about 21st century learning (Sang, Liang, Chai, Dong, & Tsai, 2018).

At the factors of 21st century skills, the result of this study showed that gender and department factors have not contributed to the emergence of 21st century skills for pre-service teachers in mathematics, biology, physics, chemistry. These findings indicated that during the learning process, pre-service teachers in mathematics, biology, physics, chemistry have obtained a 21st century skill from the learning process. This study coincides with another study showed that the creative thinking levels of preservice science teachers do not differ significantly by gender, year of study, the type of school they graduated from, or their parents' educational background (Bakır & Öztekin, 2014). The results of this study also showed that there was interaction between thinking, acting, and living indicators in the learning process. Thus, these findings indicated that the use of strategies or learning methods was thought to still be the main factor in determining the emergence of 21st century skills for pre-service teachers.

The findings of this study showed that the level of 21st century skill of pre-service teachers in mathematics, biology, physics, chemistry was limited to Indonesian qualification framework competencies. According to the Indonesian qualification framework document, the learning outcomes higher education in Indonesia must be at level 6 or/and 7. The characteristics of these levels were the learning outcomes are capabilities acquired through the internalization of knowledge, attitudes, skills, competencies, and accumulated work experience. This finding also indicates that the teachers must find a solution to overcome this problem, for example strengthen the use of learning methods (Haviz & Maris, 2018).

This study suggests that teachers who teach at mathematics, biology, physics, chemistry are better able to synthesize the 21st century skills of their students. There are several steps that can be taken that teachers have to; play a role in synthesizing 21st century students' skills, facilitate and inspire students, design and develop learning experiences, revise lesson plans, use models for teaching enhanced 21st century skills, and use the evaluating and authentic learning (Haviz, Karomah, Delfita, Umar, & Maris, 2018). Because in principle, evaluation of century-based learning is more about the products produced by students. Greenstein (2012) explains that alternative and authentic evaluations can demonstrate students' knowledge and skills in real terms. The types of assessment tools in 21<sup>st</sup> century-based learning are rubric, student contracts, self-assessment, peer reviews, observations, total records, concept maps, questioning, conferences and portfolio reviews. The teachers must conduct the assessment based on 21st century learning.

## CONCLUSION

This study provides several conclusions about the quality of instruments for 21st century skills for pre-service teachers in mathematics, biology, physics, chemistry was valid and reliable. The study found that the 21st century skill of pre-service teachers were at level 2. Gender and department factors were not a determining factor for the emergence of 21st century skills for pre-service teachers of mathematics, biology, physics, chemistry. The ability of pre-service teachers in mathematics related to physics, and the ability of pre-service teachers on biology also related to chemistry. Specifically, this study suggests the need to study the use of learning curricula and teacher perceptions as other factors in 21st century skills for pre-service teachers. The result this study suggests strengthening the use of appropriate learning methods to bring 21st century skills to the education of pre-service teachers of mathematics, biology, physics, chemistry.

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