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An Analysis of The Acceptance of Mobile-based Assessment for Student's Creative and Critical Thinking

Wahyu Ridhoni[1*], Punaji Setyosari[2], Saida Ulfa[3], Dedi Kuswandi[4]
[1*] Informatics Engineering, Hasnur Polytechnic, Indonesia
Email: wahyu@polihasnur.ac.id
[2-4] Learning Technology, State University of Malang, Indonesia
Email: punaji.setyosari.fip@um.ac.id, saida.ulfa.fip@um.ac.id, dedi.kuswandi.fip@um.ac.id

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ABSTRACT

Creative and critical thinking are two very important abilities to 21st Century. Previous mobile-based assessments have been carried out, but nothing has been used to measure creative and critical thinking. The Technology Acceptance Model (TAM) is used to see the acceptability of mobile-based assessments for creative and critical thinking. In this research, TAM is used at the prototype stage, where it is important to see the initial response of prospective users. One external variable is added to the main TAM version, namely Skill to use a smartphone. The sample of this research was 71 Informatics Engineering students. The results obtained are: (1) Mobile-based assessment for creative and critical thinking can be accepted by prospective users, (2) Skill to use a smartphone can be ignored, considering that this variable is not significant for acceptance. In other words, even though their skills are low or high, participants will still accept technology, (3) Perceived Ease to Use must be of concern because this variable is the one that has the greatest influence in the acceptance model. How to design applications that are clear, easy to understand, and have a good interaction experience will drive user acceptance.

Keywords: creative thinking, critical thinking, mobile-based assessment, technology acceptance model.

INTRODUCTION

Creative and critical thinking are two skills in higher order thinking which are very important for today's generation. Since the first notion that incorporates the importance of the two types of thinking are written by Moore (1967), those two thinking skills increasingly become attention. Additionally, they are the two of the four core abilities of the 21st century for Learning & Innovation Skills (Battelleforkids.org, 2020). Those two skills are also very necessary to face the opportunities and challenges in the Industrial Revolution 4.0 as well as a top skill needed in workplace today. Depending only on thinking critically, then solving the problem is not going to obtain diverse alternative solutions, in the meantime, if relying on thinking creatively, then a solution that is generated is not going to answer the problems that wants to be solved. Creative Thinking is the ability to think in divergent, spontaneous and random to generate alternative ways by an imagination and not common solution that has not been proven, while critical

thinking is the ability to think in a convergent, systematic, and logic to decide how to solve the problem based on the data and commonsense solutions that have been proven.

Based on previous research, there is a significant relationship between critical thinking and creativity (Hidayati et al., 2019). Creative and critical thinking are moderately correlated (Wechsler et al., 2018) and also positive (Tsai, 2019). Then it was shown any correlation between the skills to critical and creative thinking, and also to the achievement of learning (Fatmawati et al., 2019). Although these two capabilities basically separated or even has a contradictory, but both are mutually related and mutually complementary (DiYanni, 2016). Thus, measuring the ability of these should mutually co-exist. The need for a balance to think creatively and critically (Chen Tsai, 2013) reinforces the reason why both necessary and mutually complementary.

UNESCO (2014) suggests that the focus of assessment are often narrow the knowledge of traditional academic, and changed its direction to the creativity and critical thinking. Besides that, the OECD (OECD, 2019) developed PISA 2021 which is designed to also measure creative thinking. Assessment toward creative and critical thinking is the important matter, and this research wants to see how the acceptance of an mobile-based assessment for that two focused skills.

Mobile technology was chosen with the consideration of two needs that other devices do not have, namely : (1) GPS to make it easier to show where the test is located, and (2) Push Notification to send a reminder when the test is about to start and when the test results have been assessed. Cellphone is one of the devices that are possessed almost by every student in Indonesia because of the price that is affordable for all (Ulfa, 2013). It is supported by the number of mobile devices in increasingly massive use, (1) The most internet access in Indonesia is around 54.6% using a smartphone, compared to laptops and desktops for 44.9%, and tablets around 0.5% (WeAreSocial & Hootsuite, 2020), and (2) Comparison of market share in Indonesia, where the most mobile device use is around 56.65%, compared to desktops 42.82%, and tablet 0,53% (Statcounter, 2020).

Mobile-based assessment try out previously been conducted in diverse groups of subjects and students, in the elementary school (Hwang & Chang, 2011; Lai & Hwang, 2015), junior high school (Chou et al., 2017; Nikou & Economides, 2015), senior high school (Nikou & Economides, 2018; Tarighat & Khodabakhsh, 2016), students in social major (Barreiro-Gen, 2020) and exact (Fuad et al., 2018), also from a teacher's perspective (Nikou & Economides, 2019). However, from all studies conducted, none measured creative and critical thinking.

Technology Acceptance Model (TAM) is used to see the acceptance of mobile-based assessment to creative and critical thinking in Indonesia. Different from other previous TAM research which were tested when the system has been developed, in this study, TAM is used on prototype stage in which it is important to look at the response to the initial prospective users for measuring eligibility before the execution of the program in advanced. One external variable is added to the main version of the TAM, skill to using smartphones. It is the reason that the skill is one of the factors which is important in the readiness of the implementation of electronic-based learning system (Aydin & Tasci,

2005). The hypothesis in this study is arranged as many as 6 pieces as follows. The relationship between variables is illustrated in Figure 1.

H1 : Skill to using smartphone (SK) will have a significant influence on Perceived usefulness (PU)
H2 : Skill to using smartphone (SK) will have a significant influence on Perceived ease of use (PEU)
H3 : Perceived ease of use (PEU) will have a significant influence on Perceived usefulness (PU)
H4 : Perceived usefulness (PU) will have a significant influence on Attitude toward using (ATU)
H5 : Perceived ease of use (PEU) will have a significant influence on Attitude toward using (ATU)
H6 : Attitude toward using (ATU) will have a significant influence on Behavioral intention to use (BIU)

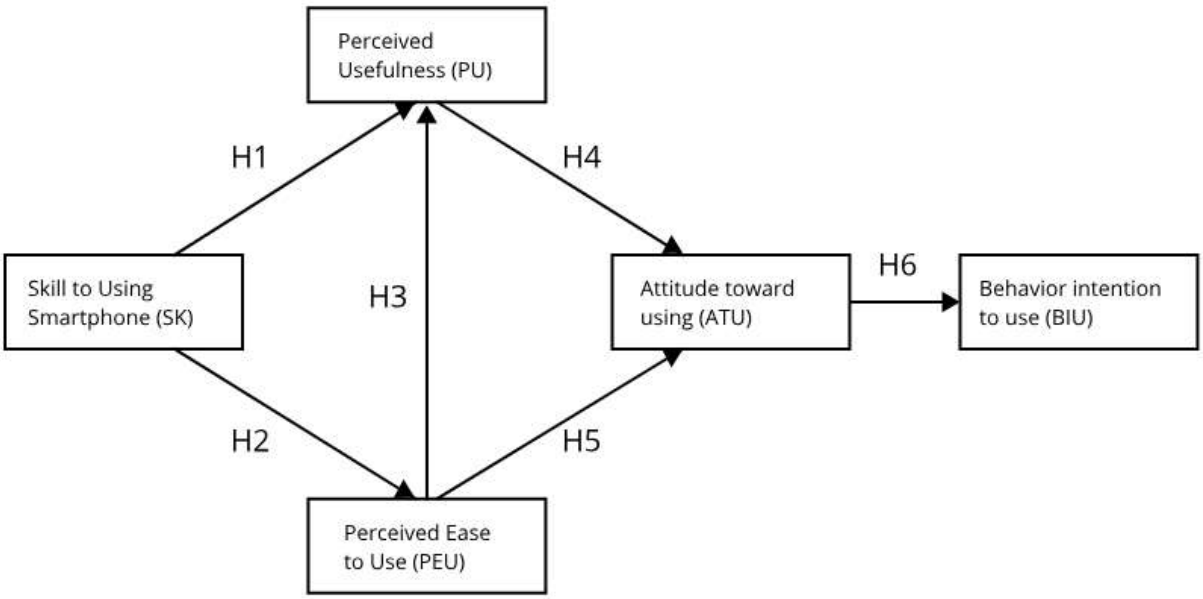

Figure 1. Conceptual Model based on TAM

METHOD

Beforehand, TAM had been conducted in the acceptability of Computer-Based Testing (Ulfa, 2017) and with similar methods, it was possible to do the mobile-based assessment. In measuring the acceptability of the mobile-based assessment for creative and critical thinking, it can be seen from perceptions, attitudes, and intentions to use technology. The flow of research procedure is shown as in the figure 2. Starting with the distribution of questionnaires to the subject of research through Google Forms in which the questionnaires of acceptance is made with TAM, and participants tried the mobile assessment system in the form of a prototype. Figma is used as a tool for designing and building prototypes. After the answers to the questionnaire are collected, the data were

tabulated and followed by analysis to obtain results and conclusions on how prospective users responded.

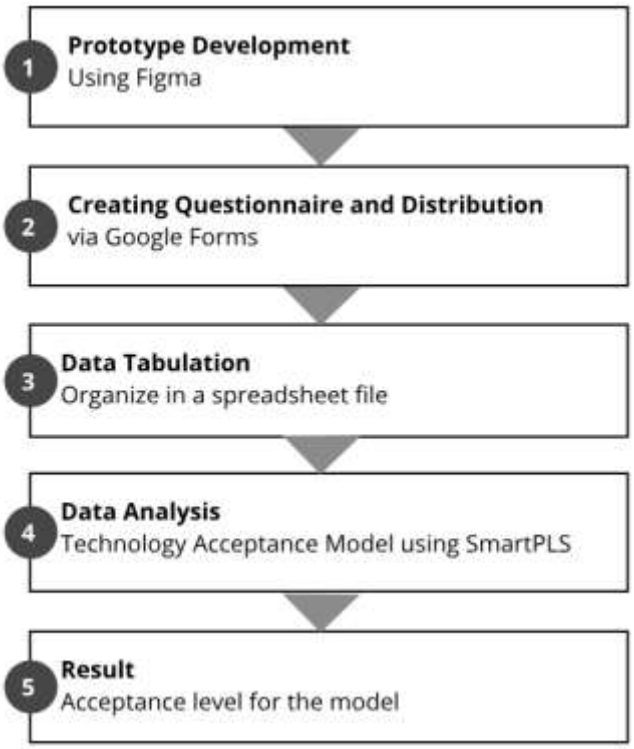

Figure 2. Procedures of Research

Sample of Research

Research sample in this research is Informatics Engineering students comprises 71 people from college located in South Kalimantan, Indonesia. They are vocational higher education / polytechnic (54, 76.1%) and academic / university (17, 23.9%). In this study, the number of males is 40 (56.3%) and female 31 (43.7%) from batch 2017 to 2020 with age range from 17 to 23 years old. Smartphone operational system used here included android around 90.1%, iOS 8.5% and both 1.4%. Meanwhile, to connect it online, most of them used mobile quotas 95.8%, the campus internet around 22.5%, and home internet is 15.5%. Informatics engineering students were prioritized as a subject of study. It is crucial to train and measure their ability to think creatively and critically. A programmer's key activity is thinking.

Instrument of Research

The list of questionnaire for this study was adapted from a study entitled Student Teachers' Acceptance of Computer Technology (Luan & Teo, 2011). It was made from scale Likert range from 1: Strongly Disagree to 5: Strongly Agree as Table 1 below. Prototypes are used to in try out process by participants as figure 3 that can be accessed on the page bit.ly/CC-Think.

Tabel 1. Questionnaire

Item	Statement
Skill to using smartphone (SK)	
SK1	I rarely have trouble connecting online
SK2	I rarely have trouble recharging my smartphone
SK3	I was able to download the application via Google Play / App Store
SK4	I usually have no trouble learning to operate new applications, even though I haven't used them before
SK5	I have used the mobile application / web for tests
Perceived Usefulness (PU)	
PU1	Using this application will improve my work
PU2	Using this application will enhance my effictiveness
PU3	Using this application will increase my productivity
PU4	I find this application a useful tool for me
Perceived Ease to Use (PEU)	
PEU1	My interaction with this application is clear and understandable
PEU2	I find it easy to get what I want to do with this application
PEU3	Interaction with this application does not require a lot of mental effort
PEU4	This application is easy to use
Attitude toward using (ATU)	
ATU1	This application make test more interesting
ATU2	Test with this application is fun
ATU3	I like using this application
ATU4	I look forward to those test that require me to use this application
Behavior intention to use (BIU)	
BIU1	I will use this application in future
BIU2	I plan to use this application often

Data Analysis

TAM model is a model commonly used in measuring the acceptance of information systems (Planing, 2014), consisting of external variables and 4 main variables. TAM has been developed into a key model in understanding the acceptance or rejection of technology. The strength of the model is confirmed by various studies that emphasize the application is broadly use in various technologies (Marangunić & Granić, 2015). TAM has been proven to be a valid and robust model in various studies (Ying Zhao & Qi Zhu, 2010). All variables were considered in TAM to support the intention of behavior (Khamaruddin et al., 2017). The TAM model with statistics is generally solved by path analysis. In this research the tools used is SmartPLS version 3. SmartPLS is a software with an easy, graphical user interface for building variance-based structural equation models.

Extension of TAM on external variables is possible (Al-Emran et al., 2018), as in research on medical education application acceptance (Briz-Ponce & García-Peñalvo, 2015). However, taking the majority of variables for investigation and reported possible as Azman et al. (2020) that only focused on the influence of perceived usefulness on attitude. In addition, TAM also can be integrated with another theoretical framework such as the Self-Determination Theory of Motivation. Therefore, this model is flexible to adjust the needs of the research. In the study of TAM, adding a new variable is gradually possible to the old model version.

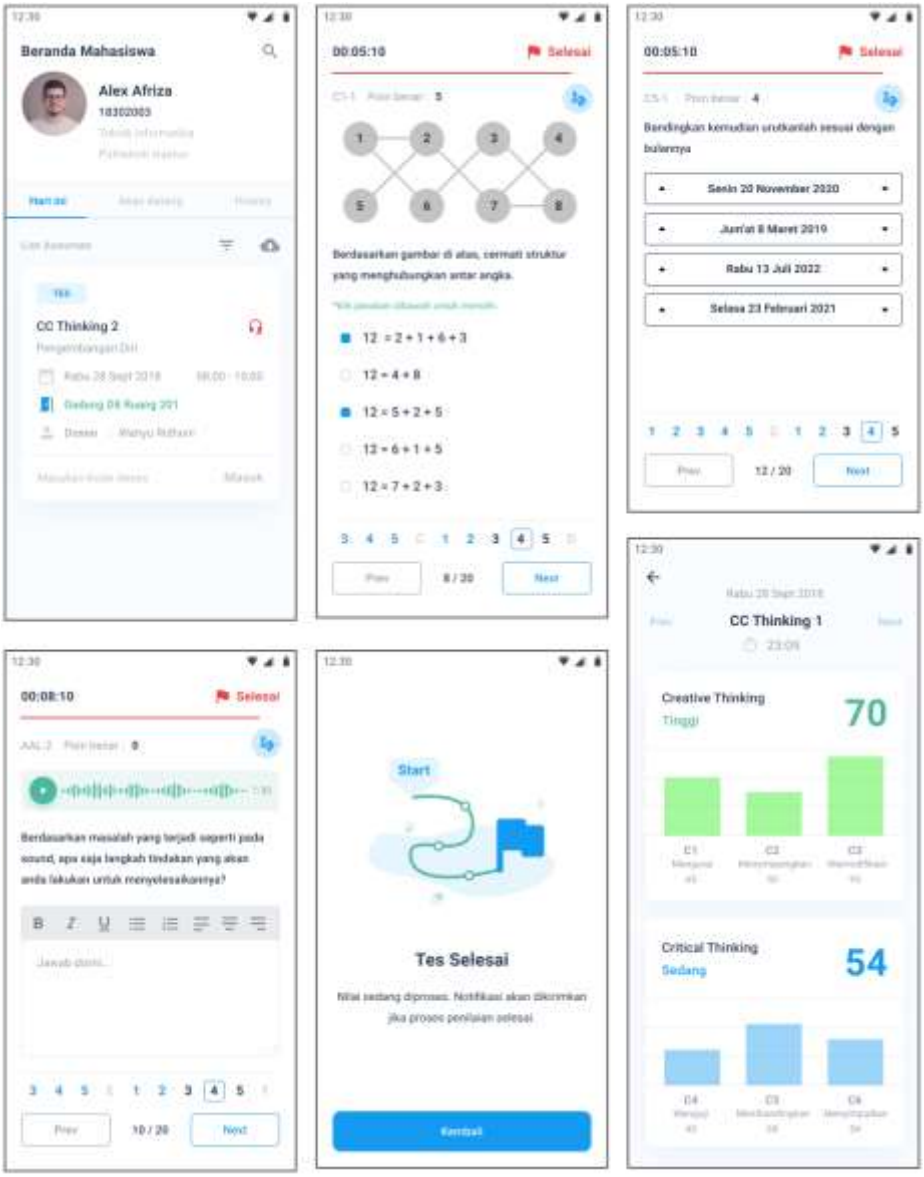

Figure 3. Prototype Interface

RESULTS AND DISCUSSION

Result

After data had been analyzed, two outputs were generated; measuring the model that was built and looking at the structural model. In the measurement of the model, it can be seen the results of test validity (convergent and discriminant) and reliability (Cronbach's Alpha and Composite Reliability) of measurement tool which are made. Then, on structural model, it can be seen the influence of exogenous variables to the endogenous variable by seeing the path coefficient and its significance. Results of the end model visually are suitable based NFI about 70.3% displayed as figure 4. NFI informed how good the model which has been generated. As with Predictive Relevance, it showed that the observation score resulted has been good with Q^2 in the fourth endogenous variable which already more than 0 as table 2 as follow.

Table 2. Construct Crossvalidated Redundancy

	SSO	SSE	Q^2
ATU	213.000	128.663	**0.396**
BIU	142.000	112.092	**0.211**
PEU	284.000	275.817	**0.029**
PU	284.000	167.638	**0.410**
SK	213.000	213.000	

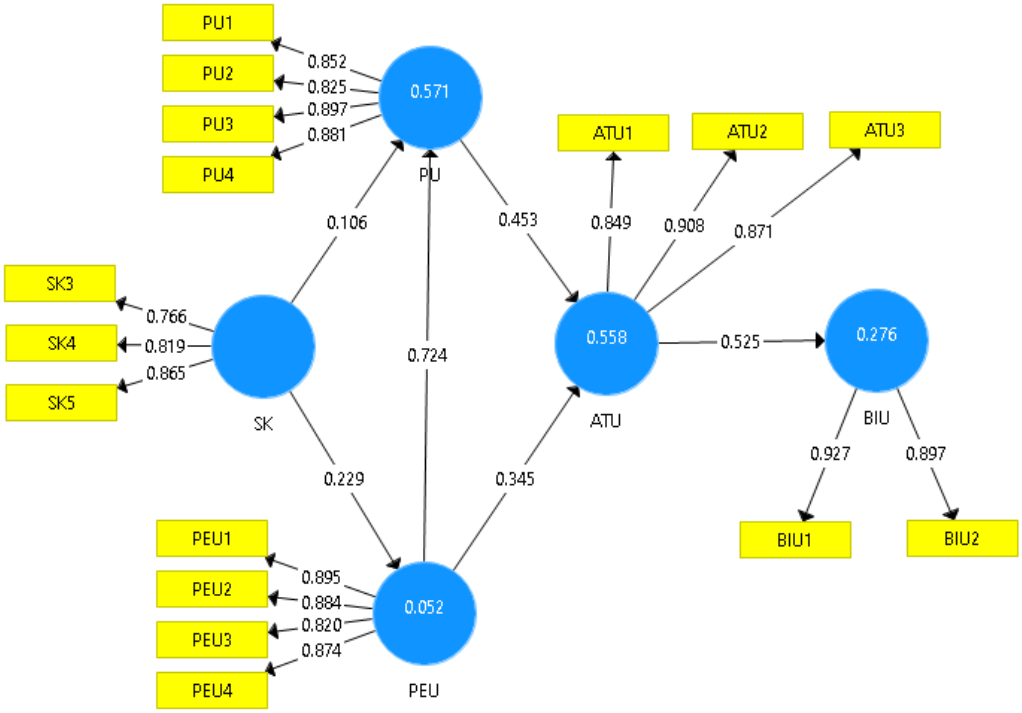

Figure 4. Result of Model

Measurement Model

Data that had been obtained after collecting data from questionnaire through Google Forms, and they were then described by displaying the mean, standard deviation, and Skewness as shown in Table 3. Furthermore, validity and reliability were conducted on the measurement instruments used.

Table 3. Statistic Descriptive

	Mean	Std Dev	Skewness
ATU1	3.606	0.778	0.464
ATU2	3.479	0.689	0.341
ATU3	3.310	0.704	0.461
ATU4	3.282	0.632	0.709
BIU1	3.465	0.747	0.847
BIU2	3.225	0.610	0.593
PEU1	3.408	0.865	0.156
PEU2	3.254	0.817	0.600
PEU3	3.324	0.835	0.060
PEU4	3.437	0.835	0.057
PU1	3.324	0.708	0.408

	Mean	Std Dev	Skewness
PU2	3.394	0.721	0.150
PU3	3.408	0.743	0.639
PU4	3.507	0.767	0.550
SK1	3.099	0.995	-0.115
SK2	3.423	0.988	-0.138
SK3	4.042	0.863	-0.486
SK4	3.366	1.010	0.208
SK5	3.775	0.907	-0.342

In validity testing with Convergent Validity, it was resulted from loading factor wherein the first time calculation, outer loading items ATU4, SK1, and SK2 less than 0.7. Therefore, the three items were deleted since the correlation of the variables are not big enough. In other words, the questions on the item that are difficult to be used as a tool measurement. It usually occured because of the variation or range of data responses were low. At the second time, after the third item are removed, it was resulting loading factor that already meet the requirements as Table 4, marked with green color.

Table 4. Loading Factor

	ATU	BIU	PEU	PU	SK
ATU1	0.849				
ATU2	0.908				
ATU3	0.871				
BIU1		0.927			
BIU2		0.897			
PEU1			0.895		
PEU2			0.884		
PEU3			0.820		
PEU4			0.874		
PU1				0.852	
PU2				0.825	
PU3				0.897	
PU4				0.881	
SK3					0.766
SK4					0.819
SK5					0.865

The validity test is continued by looking at the Average Variance Extracted (AVE), which is the average of the squares of the loading factor values. AVE is required to be in the top 0.5. The results of AVE calculations are at ATU 0.768, BIU 0.832, PEU 0.755, PU 0.747, and SK 0.669. It was shown that the all the AVE of latent variables already meet the requirements. Based on the loading factor and AVE then the relationship between the indicator with the variables have already convergent.

Validity test to see Discriminant Validity was carried out by using Fornell Larcker Criterion. It was done to see variable correlation by its variable where it should be bigger than the variable correlation from other variables. In this respect, the way happened by paying attention to the top diagonal score which should be bigger than the score at the bottom. Results of the calculations in Table 5 showed that the correlation of ATU, BIU,

PEU, PU, and SK toward its own which was written thicker, bigger compared to correlation with other variables.

Table 5. Fornell Larcker Criterion

	ATU	**BIU**	**PEU**	**PU**	**SK**
ATU	**0.876**				
BIU	0.525	**0.912**			
PEU	0.684	0.493	**0.869**		
PU	0.711	0.512	0.749	**0.864**	
SK	0.203	0.019	0.229	0.272	**0.818**

Discriminant Validity was also carried out with the cross loading by looking at correlation between the indicator and variable. Indicator which constructed the variable should more than other indicators. In Table 6, it can be seen that the score of the thick-written indicate that construct each variable toward that variable is higher than the score of the indicator towards other variables. Based Fornell Larcker Criterion and Cross Loading, it can be ascertained that each latent variable is indeed different in concept.

Table 6. Cross Loading

	ATU	BIU	PEU	PU	SK
ATU1	**0.849**	0.457	0.495	0.546	0.241
ATU2	**0.908**	0.420	0.608	0.590	0.166
ATU3	**0.871**	0.497	0.676	0.713	0.136
BIU1	0.516	**0.927**	0.530	0.477	0.086
BIU2	0.437	**0.897**	0.357	0.456	-0.065
PEU1	0.612	0.340	**0.895**	0.668	0.259
PEU2	0.686	0.562	**0.884**	0.728	0.210
PEU3	0.436	0.394	**0.820**	0.492	0.254
PEU4	0.601	0.402	**0.874**	0.676	0.084
PU1	0.544	0.419	0.598	**0.852**	0.156
PU2	0.502	0.435	0.585	**0.825**	0.165
PU3	0.681	0.550	0.744	**0.897**	0.261
PU4	0.701	0.358	0.643	**0.881**	0.333
SK3	0.111	-0.015	0.152	0.177	**0.766**
SK4	0.127	-0.056	0.208	0.205	**0.819**
SK5	0.240	0.099	0.197	0.273	**0.865**

After the validity test had been conducted which showed that the measurement instrument made is really measured what it should be measured. Then it was subsequently carried the Reliability Test to see how consistent measurement instrument used if it was used in repeatedly. Cronbach's Alpha showed the score of ATU 0.850, BIU 0.800, PEU 0.892, PU 0.887, and SK 0.755. Then the calculation of Composite Reliability indicated that the score of ATU 0.908, BIU 0.908, PEU0.925, PU 0.922, and SK 0.858. Both calculations of all variable scores are more than 0.7, so it can be stated that the measurement instrument has been reliable.

Structural Model

Based on the R Square value owned by endogenous variables, it can be seen that ATU is influenced by 55.8% by the PE and PEU, the rest is influenced by variables not studied. BIU was affected by 27.6% by the ATU, the rest was influenced by variables that were not investigated. PEU was affected by 5.2% SK, the rest was influenced by variables that were not investigated. Then PU was affected by 57.1 % of SK and PEU, the rest was influenced by variables that were not investigated.

Table 7. Path Coefficient

	ATU	BIU	PEU	PU	SK
ATU		0.525			
BIU					
PEU	0.345			0.724	
PU	0.453				
SK			0.229	0.106	

Results of Path Coefficient as in table 7, it can be known all the exogenous variables which had positive influence on the endogenous variable. Path coefficient score in the range from -1 to 0 meaning that the effect was negative, but if 0 to 1 meaning that it has positive influence. The negative influence showed that the higher the score of the exogenous variable, the lower the score of the endogenous variable that it affects, but when it is positive, it shows that the higher the score of the exogenous variable, the higher the score of the endogenous variable it affects. The high of the effect is based on the coefficient score on the path that connects the exogenous variable and endogenous variable.

If the path coefficient can be seen from its influence, then at table 8, it can be seen significant influence by carrying out the bootstrapping. In bootstrap, sub-sample was made with the observation that taken by random with replacement from the set of original data. Data on bootstrap was generated automatically by SmartPLS. To ensure the stability of the results, the number of sub- samples was set to number as many as 500. How the level of confidence to a hypothesis, whether accepted or rejected can be known.

There were four T-Statistics that more than 1.96 or P-Values less than 0.05, namely ATU to BIU, PEU to the ATU, PEU to PU and PU for ATU, marked with the green color. Then there are two T- Statistics that less than 1.96 or P-Values is more than 0.05, namely SK to PEU and SK to PU, marked with the red color. This value is if it is tried with bootstrapping repeatedly will produce T-Statistics and P-Values which are not exactly the same, but it consistently will produce the same result of final decision.

Table 8. T-Statistic

		T Statistics	P Values
ATU	? BIU	4.094	**0.000**
PEU	? ATU	2.138	**0.033**
PEU	? PU	11.524	**0.000**
PU	? ATU	3.590	**0.000**
SK	? PEU	1.634	**0.103**
SK	? PU	1.147	**0.252**

Discussion

In general, previous research in the mobile -based assessment was on how to use mobile devices in assessments and see their effects on students. Mobile-based assessment has advantages because students can bring their own device (Chou et al., 2017) and can arrange where the assessment is carried out according to a GPS-based moving point or route (Santos et al., 2011). Compared to conventional test approaches, learning satisfaction is much (Nikou & Economides, 2018), as an alternative which more interesting than paper and pencil assessment procedure (Nikou & Economides, 2016).

The similar as other online-based assessments, mobile-based assessment can simplify the management of examinations (Meletiou et al., 2012), can also be designed with rich visual (Andrews et al., 2018), interactive (Fuad et al., 2018), even adaptive (Louhab et al., 2018). Various types of assessment can also be done with assisted mobile system, such as the peer assessment in which students can each look at and assess the work of his friends (Lai & Hwang, 2015). Its implementation can be in the various environment such as in the classroom, outside the room, and even homework. Most consider that it a positive assessment. In addition, it is also useful and easy to use. However, being unable to connect to the internet is a note that to be taken as a concern (Stowell, 2015).

Related researches to the acceptance of mobile-based assessments are many conducted by Stavros A. Nikou & Anastasios A. Economides. Therefore, in the discussion of the results of this study, there will also be many reflections and refers to the previous findings by Stavros A. Nikou & Economides. Earlier studies confirmed that the Technology Acceptance Model in predicting acceptance of students in the context of the mobile-based assessment (Nikou & Economides, 2014). Mobile-based assessments are considered useful and easy to use, also students like to adopt them (Nikou & Economides, 2015). All TAM main variables often proved influential significant, only a few external variables were not significant (Nikou & Economides, 2017). However, in studies in which participants are STEM (Science technology and Mathematics) teachers was resulted in every path either on main variable either external variable that there was significant positive influence (Nikou & Economides, 2019).

Based on the results of this study, Attitude toward its significant use is influenced by perceived ease of use and perceived usefulness as it is in line with research conducted by Hardyanto et al. (2019), R-Square 0.558 is quite strong to explain the factor in the effect of perceived ease of use and perceived usefulness. Similarly, Attitude Toward Using is significant over behavior intention to use, as is also the same result in the research by Abramson et al. (2015), with R Square is only 0. 276 which explained that Attitude Toward Using was not rather dominant factor over Behavior Intention to use. There are still many other factors in addition to Attitude Toward Using which has not been studied that affect the Behavior Intention to use. It is different from Farahat (2012) which showed Attitude Toward Using became a strong predictor for the intention to use. Then on the other research that Perceived Ease of Use even has no effect (Jan & Contreras, 2011) and the factor is not stable (DongPing Tang & LianJin Chen, 2011), but that results are not happening in this study. In addition, the same result with research conducted by Setianto & Suharjito (2018) which indicated that the Perceived Usefulness is more dominant than the Perceived Ease of Use over Attitude Toward Using.

Perceived Usefulness got the highest R Square around 0.571 since the skill factor in using smartphone does not significantly affect Perceived Usefulness, then the Perceived Ease to Use is the factor that makes a big contribution. Although Perceived Usefulness also affects the Attitude Toward Using, the influence of Perceived Ease to Use to the Perceived Usefulness is higher than the impact to the Attitude Toward Using directly. This shows that before users feel the app is useful for them, a prerequisite that the ease of use becomes a necessity. They just may find it useful if when trying, it felt easier. On the other hand, if from the beginning of the application is considered to be difficult to operate then the user will perceive that the application is not useful.

Then, Attitude Toward Using is proven to be influenced positively and significantly by Perceived Ease of Use and Perceived Usefulness, and Behavior Intention to use is influenced positively and significantly by Attitude Toward Using. However, Skill to Using a smartphone does not significantly affect Perceived Ease to Use or over Perceived Usefulness. It is predicted that the cause is the participants in the study are students of Informatics Engineering are generally already familiar with the digital technology. Elaboration of the results of the hypothesis testing is displayed below :

H1 : Skill to using smartphone (SK) had NOT a significant influence on Perceived usefulness (PU)
H2 : Skill to using smartphone (SK) had NOT a significant influence on Perceived ease of use (PEU)
H3 : Perceived ease of use (PEU) had a significant and positive influence on Perceived usefulness (PU)
H4 : Perceived usefulness (PU) had a significant and positive influence on Attitude toward using (ATU)
H5 : Perceived ease of use (PEU) had a significant and positive influence on Attitude toward using (ATU)
H6 : Attitude toward using (ATU) had a significant and positive influence on Behavioral intention to use (BIU)

CONCLUSIONS

The findings of this research support the Technology Acceptance Model in which the structure of the four main variables that consists of Perceived Usefulness, Perceived Ease to Use, Attitude toward using, and Behavior Intention to use is empirically very fit. The effect that connects the four variables is proven to be significant and positive. However, the Skill to Use a smartphone that is added as an external variable is not significant, re- testing on a different subject may be necessary.

In connection with the initial response of prospective users to mobile-based assessments for creative and critical thinking, it can be concluded: (1) mobile-based assessments for creative and critical thinking can be accepted by prospective users, (2) Skill to use smartphones can be ignored, considering that this variable is not significant for acceptance. In other words, although the skill is either low or high, the participant will still accept the technology and does not affect significantly to their initial perception, (3) Perceived Ease to Use should be a concern for this variable has the big influence in the acceptance model. How to design applications that are clear and easy to understand, and a good interaction experience will encourage users' acceptance.

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