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Berpikir Level Tinggi dan TPACK Calon Guru Matematika pada Pembelajaran Matematika Abad ke-21

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Abstrak

Pembelajaran matematika pada abad ke-21 membutuhkan proses berpikir tingkat tinggi dan penguasaan teknologi. Manfaat penggunaan teknologi yang disertai dengan pemikiran tingkat tinggi antara lain 1) memiliki banyak alternatif pemecahan masalah, 2) menjadi rekan kerja yang baik, dan 3) lebih mandiri dalam mencari solusi. Selain itu, pembelajaran matematika merupakan salah satu mata pelajaran utama di kelas dan memiliki ciri utama pembelajaran yang terstruktur dan memiliki alur yang sistematis. Atribut pembelajaran matematika yang ada dapat mendukung proses pembelajaran teknologi, yang juga memiliki sistem dan algoritma yang teratur. Penelitian ini menggunakan metode survei potong lintang yang mengeksplorasi pemikiran tingkat tinggi dan *Technological Pedagogical Content Knowledge* (TPACK) dalam pembelajaran matematika. Subjek penelitian adalah 182 calon guru matematika di Universitas Muhammadiyah Purwokerto, Indonesia. Penelitian ini menunjukkan item-item yang terkandung dalam berpikir tingkat tinggi, dan TPACK cukup untuk dilakukan analisis faktor, yaitu berada pada nilai 0.657 dan 0.783 ($\lambda > 0.50$). Hasil penelitian menyatakan bahwa berpikir tingkat tinggi merupakan modal penting dalam pembelajaran matematika. Oleh karena itu, pembelajaran matematika juga menuntut dinamisme perkembangan teknologi untuk menunjang keberhasilan pembelajaran matematika.

Kata Kunci: berpikir level tinggi, pembelajaran matematika, TPACK

High-Level Thinking and TPACK of Pre-Service Mathematics Teachers in the 21st Century Learning

Abstract

In the 21st century, learning requires high-level thinking processes and mastery of technology. The benefits of using technology accompanied by high-level thinking include 1) having many alternative solutions to problems, 2) be a good co-worker, and 3) being more independent in finding solutions. Also, learning mathematics is one of the main lessons in class and has the main characteristics of structured learning and has a systematic flow. The attributes of existing mathematics learning may support the technology learning process, which also has an orderly system and algorithm. This study employed a cross-sectional survey—it exploring high-level thinking and TPACK in mathematics learning. The subject was 182 pre-service mathematics teachers in Universitas Muhammadiyah Purwokerto, Indonesia. This study showed high-level thinking, and TPACK indicated that the item was sufficient to perform factor analysis. The analysis results found that the Kaiser Meyer-Oikin (KMO) value for items in the high-level thinking construct questionnaire with 12 items showed 0.657 ($\lambda > 0.50$). Subsequently, in TPACK construct questionnaire with 32 items showed 0.783. The results stated that higher-order thinking is the essential capital in learning mathematics. Therefore, learning mathematics also demands the dynamism of technological developments to support the success of learning mathematics.

***Keywords**: high-level thinking; mathematics learning; TPACK*

INTRODUCTION

In the 21st century era, learning requires fast and critical thinking processes and mastery of technology (Lamichhane, 2018). The fulfilment of higher-order thinking is a systematic, broad and detailed way of thinking in solving problems in learning (Connie, 2020). The use of technology can assist problem-solving in learning in the 21st century. Therefore, knowledge in using technology (Naismith et al., 2016). Mastery of systematic thinking supported by proficiency in operating technology in learning becomes the essential capital to create success in education (Kelvin, 2020). So, to improve the quality of learning in the 21st century, high thinking processes and knowledge in technology are needed.

In addition, high-level thinking requires a creative thinking process. Creative thinking skills in problem-solving activities in education are needed to identify problems, see problems from various perspectives and explore ideas used to solve problems (Widodo & Turmudi, 2017). In addition, creative thinking in solving problems is used to identify possible solutions and find the most suitable solution method (Richard, 2018). 21st-century learning sees that problem-solving can be solved with the help of technology. Learning with technology becomes an activity in the classroom (Bhattacharjee & Deb, 2016). Thus, creative thinking supported by knowledge of using technology becomes the essential capital of an educator in supporting learning success.

Subsequently, according to Anggoro et al. (2014), critical thinking is also part of high-level thinking that teachers must-have in the 21st century. In learning, the teacher finds all elements used to create learning objectives. One of the aspects considered is the use of technology (Kelvin, 2020). The technology used in classroom activities must have advantages and benefits for teachers and students. By thinking critically, teachers better understand how to use technology most effectively to create meaningful learning (Farisi, 2016). According to Anggoro et al. (2014), other benefits of using technology accompanied by critical thinking include 1) having many alternative solutions to problems, 2) be a good co-worker, and 3) being more independent in finding solutions. With technology, teachers can solve problems in various ways, and the critical thinking process makes it easier for teachers to see the best way (Eynde & Corte, 2020). In addition, technology can be a teachers' partner. It is confirmed by Vinoth and Nirmala (2017) that technology is the second home of humans in carrying out social activities, including education. The process of critical thinking can sort out practical human activities with technology and social activities with actual conditions with fellow humans Anggoro et al. (2014). On the other way, Imam (2016), the demands of the 21st century require teachers to be more independent in taking attitudes and planning lessons.

Implementation of learning can occur if communication can be carried out correctly. Communication skills are essential to be developed in understanding (Connie, 2020). Communication skills in the 21st century is a crucial part of implementing learning. It is due to technology being a means to help solve problems. Teachers as technology users must also be proficient in understanding language and communication, both verbal and technological language (Ibrahim & Wekke, 2009). In addition, to create conducive learning conditions in the classroom, teachers need to learn the excellent language used in class (Bingimlas, 2009). The use of language in technology is also essential to know to maximize the use of technology. So that teaching in the classroom can create harmonization between teachers and students verbally as well as teachers and students virtually (Syah, Darmawan, & Purnawan, 2019).

Subsequently, to improve learning, especially mathematics learning, it can be done with two skills: higher-order thinking and TPACK (Doğan, 2012). In line with Talib et al. (2016), learning mathematics is one of the main lessons in class and has the main characteristics of structured learning and has a systematic flow. The attributes of existing mathematics learning may support the technology learning process, which also has an orderly system and algorithm (Weippert, Achim, & Kajewski, 2017). Therefore, it can be explained that in learning mathematics, technology can be used appropriately.

The success of learning mathematics using technology cannot be separated from the TPACK ability of the teacher (Restiana, 2018). With the TPACK knowledge possessed and mastering higher-order thinking, it can be used in mathematics learning technology (Wahyuni, 2019a). According to Maesuri et al. (2016), TPACK has three main characteristics: Content knowledge, Technology Knowledge, and Pedagogy Knowledge. These three characteristics underlie teachers in using TPACK in the classroom. Knowledge of mathematical content can be interpreted as the ability of teachers to understand and operate symbols and mathematical concepts (Lisa, 2020). Mathematics as knowledge places ideas as one object. Abstract mathematical objects can contain facts, ideas, operations, procedures and principles (Kaput & Thompson, 1994).

Additionally, Fu (2019) stressed that teachers need to master two components of knowledge, namely content knowledge and pedagogy of a subject. Content knowledge refers to the knowledge of the curriculum, content and learning outcomes of a subject. Meanwhile, pedagogical knowledge is knowledge related to approaches and techniques to deliver the content of the subject. Previous studies have proven the need for teachers to possess content knowledge and pedagogical knowledge in ensuring they provide effective teaching. Technology content knowledge is also a category used to distinguish the comprehension characteristics of a Mathematics content expert with that of a technology expert (Yigit, 2014). Teachers with good technology content knowledge are able to produce productive questions in the classroom (Valtonen et al., 2017).

Meanwhile, mathematical concepts in the classroom cannot be separated from how the teacher can link several alternative formulas to solve the problems faced (Mapolelo & Akinsola, 2015). The acquisition of these abilities is based on a good knowledge of mathematical concepts (Paul Chow & Pepe, 2019). In terms of successful learning in the classroom, conceptual understanding and pedagogical knowledge can synergize with technological knowledge (Lisa, 2020). The pedagogical expertise possessed is the primary capital for teachers to teach. Another supporting factor in today's technological era, teachers must have good knowledge of technology (Talib et al., 2016). Therefore, the three elements of teacher knowledge (mathematical concepts, pedagogy, and technology) become weapons for teachers in creating meaningful learning.

The process of learning mathematics is essential for students in the 21st century because it includes the provision of logical, critical, and systematic thinking (Warner & Kaur, 2017). Higher-order thinking requires an analytical, critical and systematic thinking process (Schlesinger & Wang, 2019). So, it can be explained that higher-order thinking is the essential capital in learning mathematics (Wulan, 2017). In addition, learning mathematics also demands the dynamism of technological developments (Rahmadi, 2019). According to (Maesuri, 2018) technological developments can support the success of learning mathematics. Proficiency in using technology in mathematics learning is required. Therefore, mastery of TPACK is a must for teachers to use technology in the classroom (Yuli, 2017).

This study investigates high-level thinking and the TPACK of pre-service mathematics teachers in the Banyumas, Indonesia. In previous studies, it was explained that higher order thinking has a strong relationship with TPACK. In addition, high-level thinking is needed in mastering technology in this 21st century. However, previous research hasn’t investigated pre-service mathematics teachers of high-level and TPACK in Banyumas, Indonesia. Therefore, we interested in looking further at the process of the two high-level thinking and TPACK in learning mathematics.

METHOD

This study employed quantitative research with a cross-sectional survey method (Creswell, 2014). This research explores the relationship between high-level thinking and TPACK of mathematics education pre-service teachers in Universitas Muhammadiyah Purwokerto in 2020-2021 academic year. The relationship between the two variables can later be explained through a structural equation model. The population in this study is pre-service mathematics teachers in Mathematics Education department. This study took a sample of 182 pre-service mathematics teachers consist of 3^{rd}, 5^{th}, and 7^{th} semester.

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Table 1. The High-Level Thinking Questionnaire Items

Item	Questionnaire Statements
1.	I am able to understand each of the media content in mathematics learning
2.	I understand the content of the material in learning Mathematics
3.	I know the rules for using digital media through the contents of the instructions for use
4.	The ability to collect information contained in the media and analyze
5.	I am able to do assignments and problem descriptions on Mathematics learning content
6.	I am enthusiastic about mathematics learning
7.	I am able to do the exercises that exist in Mathematics learning media
8.	I did all the exercises carefully
9.	My accuracy in doing the exercises according to the specified time
10.	I am able to work on problems in learning according to the orders given
11.	I am able to exchange ideas with friends about the context of the material during learning
12.	I am able to discuss about learning media content

We also employed two instruments of High-Level Thinking and TPACK and took five-likert scale instruments.The High-Level Thinking was consisting of 12 items (see Table 1) and 32 items for TPACK instruments (see Table 2).

Table 2. The TPACK Questionnaire Items

Item	Questionnaire statements
1.	I easily learn and use computer technology
2.	I follow the latest developments in computer technology
3.	I know how to solve technical problems with my computer
4.	I have the technical ability to use computers effectively
5.	I can use the internet as a medium of communication (such as email, yahoo messenger, whatsapp, or others)
6.	I can use social media (like facebook, twitter, Instagram, or others
7.	I have sufficient knowledge of mathematics content
8.	I follow the development of Mathematics
9.	I have a variety of ways and strategies to develop an understanding of mathematics content
10.	I can use the latest sources or references (such as books and journals) to increase my mathematical knowledge
11.	I design and apply mathematics for learning purposes
12.	I can apply a variety of learning strategies
13.	I can recognize the possibility of learning difficulties
14.	I can adapt my learning style to my abilities
15.	I can help friends to solve the problems they are experiencing
16.	I can plan group activities with friends
17.	I use technology to help understand mathematics concepts
18.	I know and can use computer applications related to mathematics
19.	I can develop learning activities and assignments by involving the mastery of the technology
20.	I can choose and use appropriate technology with mathematics concepts
21.	I can make group learning activities with friends by using existing video teleconference technology (such as zoommeeting, googlemeet, etc)
22.	I can make a good study plan about the materials I will study
23.	I can make difficult math material easy by using technology
24.	I can help my friends to understand math material with various strategies even without using technology
25.	I can invite friends to discuss math material without the help of any technology
26.	I can solve math problems without using technology
27.	I can use computer applications in every math lesson
28.	I can use internet facilities such as social media, email, blogs to communicate with friends
29.	I can use technology to find more information independently
30.	I can use technology to construct various forms of knowledge representation
31.	I can choose learning strategies and technology that are suitable for mathematics content
32.	I can understand how to combine mathematical knowledge to realize meaningful mathematics learning

This study uses exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation model (SEM) (Byrne, 2013). There are many opinions regarding the number of study respondents required for EFA, CFA, and SEM analysis. All data collected through four research instruments were entered and analyzed using SPSS software, then analyzed using Structural Equation Model-Analysis of Moment Structure (SEM-AMOS). SEM-AMOS is a multivariate analysis technique that combines regression analysis, band analysis, factor analysis and structural model (Piaw, 2016). SEM-AMOS also has several advantages, being able to test relationships between complex and dynamic variables simultaneously that cannot be done by other statistical analysis, comprehensive model testing, enabling the expansion of existing theories, models and concepts into a new model corresponding to respondent data as a research contribution (Hair et al., 2014).

The formation of a structural model requires data screening conducted through exploratory factor analysis, pooled validation factor analysis, validity index, reliability and acceptable goodness of fit index for all instruments. In this study, the researcher refers to two modelling steps that have been proposed by Kline (2017):1) test the measurement model first to get the match with the data and then 2) test the structural model formed by relating the measurement model with enablers change or between all measurement models. Pooled CFA was used to test the fit of the measurement model (Piaw, 2016). Hair et al. (2014) stated that CFA analysis was used to verify the extent to which the measurement model measures the variables that represent the construct. The pooled CFA results were used to test the validity and reliability of the constructs. Items with a loading factor ($\lambda<0.05$) will be discarded, and then the model will be evaluated statistically using a goodness-of-fit index to ensure that the model has a good match with the respondent's data. If the model has reached an acceptable fit, the analysis will test the structural model.

RESULT AND DISCUSSION

The results of this study consist of the reliability value, the Exploratory Factor Analysis (EFA), The Confirmatory Factor Analysis (CFA), and The Structural Equation Model (SEM). The details of this information are as follows.

The Reliability

Considering that the selection of response was according to the Likert scale for the mathematical reliability instrument and mathematical experience, Cronbach's alpha was used to obtain the internal reliability index of the tool (Cohen, Manion, & Morrison, 2017). This reliability was essential to determine whether the instruments developed in different cultures and educational systems can be applied to different cultures and educational systems.

Table 3. The Reliability of The Constructs Study

Construct	Sub-construct	Cronbach Alpha Value
High-Level Thinking (HT)	Analytical Evaluation (AE)	0.770
	Creative Thinking (CR)	0.718
TPACK	Content Knowledge (CK)	0.739
	Pedagogical Knowledge (PK)	0.849
	Technological Knowledge (TK)	
	Technological Pedagogical Knowledge (TPK)	0.759
	Technological Content Knowledge (TCK)	0.770
	Pedagogical Content Knowledge (PCK)	0.739
	Technological Pedagogical Content Knowledge (TPCK)	0.849

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Kline (2017) stated that Cronbach's alpha value was between 0 (indicating no internal trustworthiness) and 1 (indicating perfect internal trustworthiness). The generally accepted minimum value of Cronbach's alpha is 0.7 (Hair et al., 2014). Therefore, a multiplier interpretation of trustworthiness that practitioners of social science practitioners can accept is the value exceeding 0.70. So, in this study, the Cronbach's alpha value used is 0.7 and above. Table 3 shows a summary of the Cronbach alpha trustworthiness value for the HT and TPACK instruments.

Exploratory Factor Analysis (EFA)

The analysis results found that the Kaiser Meyer-Oikin (KMO) value for items in the high-level thinking construct questionnaire with 12 items showed 0.657. Subsequently, in TPACK construct questionnaire with 32 items showed 0.783. whereas high-level thinking and TPACK construct are more than 0.50, indicating that the data do not have serious multicollinearity problems and the items are suitable for factor analysis. Barlett's test of Sphericity showed a significant value of 0.000 ($p < 0.05$) for the two constructs, indicating that the item was sufficient to perform factor analysis.

To ascertain the number of critical factors extracted as the main factors in the high-level thinking and TPACK questionnaires, we examined the scree plot graph of the high-level thinking, and TPACK tested (See Figure 1(a) and 1(b)). Based on EFA analysis found that there are two factors for high-level thinking and seven factors in TPACK construct. All these factors accounted for 58.739 and 63.592 separately of the overall variance concern. The plot scree graph shows that two main factors contribute significantly to the overall variance change in the high-level thinking and TPACK variable.

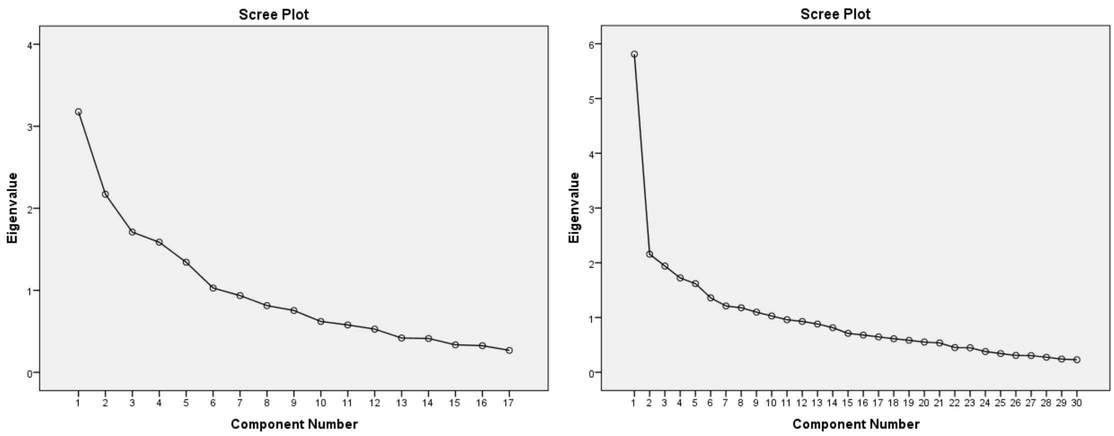

Figure 1. High-Level Thinking Scree Plot (Left); TPACK Scree Plot (Right)

Confirmatory Factor Analysis (CFA)

The CFA were used to determine whether the hypothetical model fits the given data set or not (Byrne, 2013). To view this analysis, several values were obtained, namely factor loadings, variance and *Modification Indices* (MI) in order to obtain the most suitable model. In determining the fit model, several values have been adopted by Kline (2017) suggesting at least four tests should be used, namely: Chi-square, *Goodness of Fit Index* (GFI), *Normed Fit Index* (NFI) or *Comparative Fit Index* (CFI). *Normed Fit Index* (NNFI) and *Root Mean Square Residual* (SRMR). In this study, there are six fit indices used: *Absolute Fit Measure* (AGFI), NFI, *Tucker Lewis Index* (TLI), *Incremental Fit Index* (IFI) and CFI (Byrne et al. 2009; Hair et al. 2014). Values for this index range from 0 to 1.00. Value 0.90 and above as a good matching model. As for the Parsimonious Fit Measure (CMIN/df), there are researchers who allow values up to 5 to achieve model fit. Similarly, there are researchers who use a value of 2 or less. However, in this study the value used for CMIN/df is less than 3 (CMIN/df <3).

Moreover, the condition that is often used for the fit index is above 0.90. The fit index used in this study was 0.90 and above. *Root Mean Square Error of Approximation* (RMSEA) is also used to determine the suitability of the research model. The index is sensitive to the estimated number of parameters in the model. There are several levels of acceptance for the appropriateness measure of the

RMSEA value, which is between 0.03 and 0.08 (Hair et al., 2014). The RMSEA value used in this study was between 0.03 and 0.08 with 95% confidence (Hair et al., 2014).

Based on the CFA analysis, the High-Level Thinking (HT) construct is divided into two aspects: Analytic Evaluation/ AE (LT 1, 2, 3, 4, 11, and 12) and Creative Thinking/ CR (LT 5, 6, 7, 8, 9, and 10) (See Figure 2). The equivalence index is checked to ensure that the hypothesized model is commensurate with the respondent's data. The results of the CFA analysis for High-Level Thinking are the root Mean Square of Error Approximation (RMSEA) value is 0.128, the Comparative Fit Index (CFI) = 0.865, the Tucker-Lewis Index (TLI) = 0.832, the Normed-fit Index (NFI) = 0.830, and the value of Chi-Square/df = 3,967.

Meanwhile, the findings of this study indicate that the potential of High-Level Thinking is needed in TPACK construct. Suitable to van Borkulo et al. (2019), who stated that TPACK in mathematical content involves mathematical cognitive processes, consistent and strategic on High-Level Thinking skills.

According to Puspitarini and Sunaryo (2018), their study found that the increase in High-level Thinking can influence TPACK. Meanwhile, knowledge of technical content in the teaching of Mathematics can also affect the understanding of technology pedagogy. The high value of the relationship between the two types of relationships is likely to make teachers master the technology of teaching Mathematics. Teachers are expected to be proficient in teaching pedagogy as a tool to teach Mathematics using technology. Specifically, some interview participants focused more on teaching based on high-level thinking developments, such as creative thinking, analytical thinking, and critical thinking. In this case, the interview participants were more likely to emphasize constructivism skills by attending skills workshops provided by the school or the government.

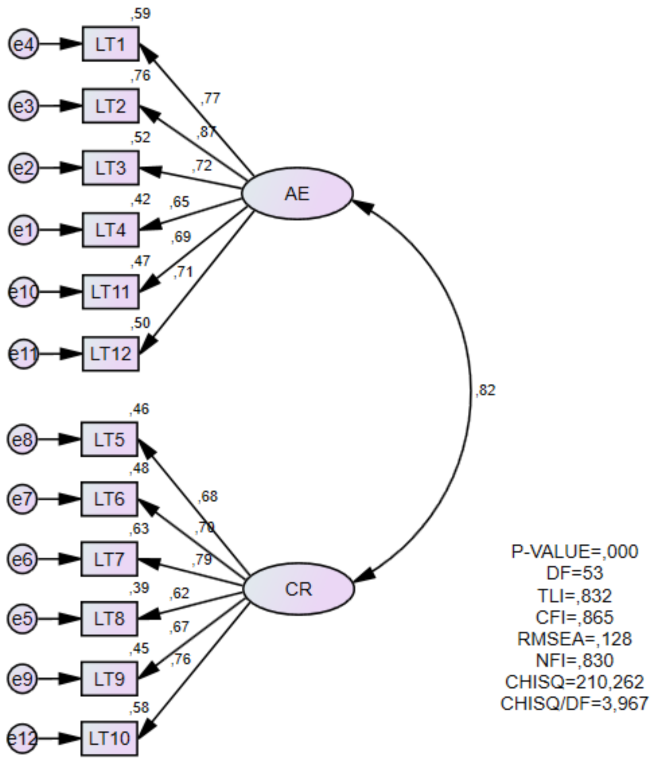

Figure 2. CFA of High-Level Thinking

Subsequently, TPACK construct consists of seven aspects: Content Knowledge/CK (TP 6, 7, 8, and 9), Pedagogical Knowledge/PK (TP 10, 11, 12, 13, and 14), Technological Knowledge/TC (TP 19, 20, 21, and 22), Technological Pedagogical Knowledge/ TPK (TP 23, 24, 25, 26, and 27), Technological Content Knowledge (TP 1, 2, 3, 4, and 5), Pedagogical Content Knowledge/ PCK (TP 15, 16, 17, and 18), and Technological Pedagogical Content Knowledge/ TPACK (TP 31, 32, 33, and 34) (See Figure

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3). Also, the CFA analysis for TPACK obtained RMSEA = 0.101, CFI = 0.704, TLI = 0.667, NFI = 0.614, Adjusted Goodness-of-Fit Statistics (AGFI) = 0.622, and Goodness-of-fit Statistics (GFI) = 0.685.

Without a solid knowledge in all aspects of TPACK, they find it challenging to deliver High-Level Thinking in the classroom. It is because pre-teachers need a combination of analytical evaluation thinking and technological knowledge. In line with the findings of this study that the relationship between analytical evaluation thinking and technical expertise is low. According to Dicky (2019), for pre-teachers, the construction of pedagogical knowledge is also influenced by the knowledge possessed when starting the teaching profession. Whereas TPACK should provide and modify the suitability of the technology and subject to an assessment of their creative thinking as teachers (Restiana, 2018). In this regard, Lisa (2020) argued that knowledge of technology coaching is essential to focus full attention on technological problems in the teaching of Mathematics. Although studies in Indonesia show, technical guidance is done to reveal creative thinking problems that occur in the learning of Mathematics and modification with technology (Yoppi, 2017).

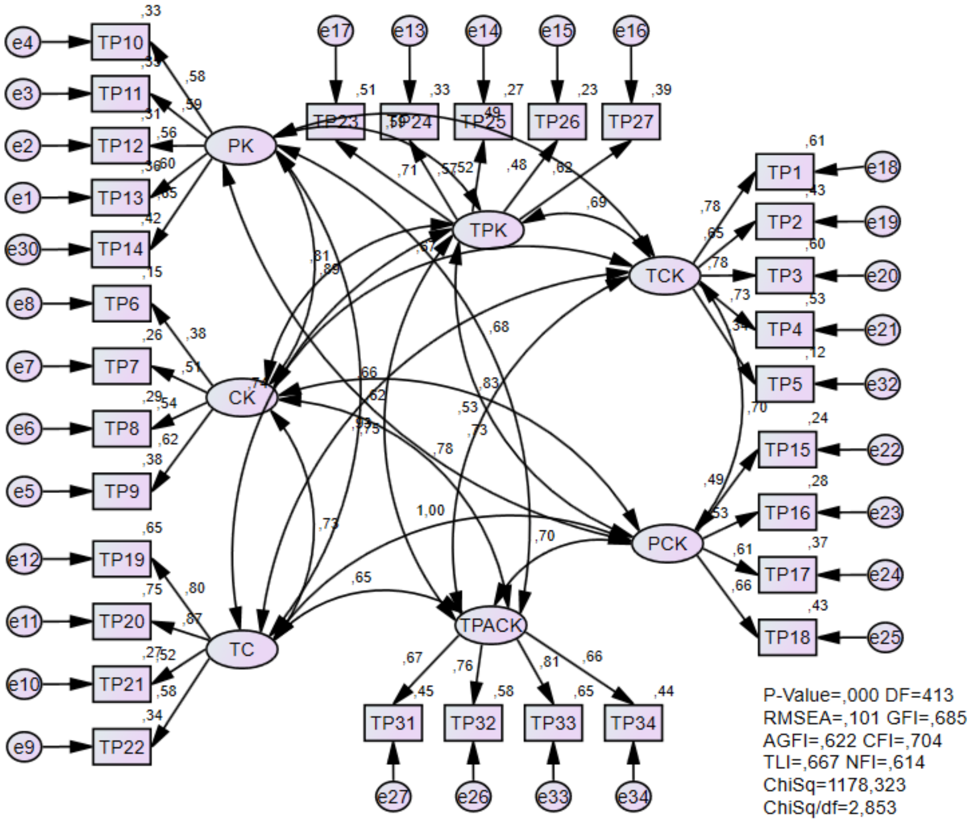

Figure 3. CFA of TPACK

Meanwhile, the relationship between analytical evaluation thinking and technology pedagogy knowledge occurs due to the harmony between the knowledge possessed and how the learning is delivered using technology. There is no denying that teachers master how to solve technological problems and apply technology to mathematics teaching. In line with Maesuri (2018), teachers use some Mathematics software such as Kahoot and Praxis to teach Mathematics. The knowledge of technology content possessed by teachers places much emphasis on teaching technology-based mathematics. It also supports the understanding of technology pedagogy that teachers have.

According to Lamichhane (2018), among the content knowledge involving the mental processes of Mathematics that are consistently and strategically involved in pedagogy is abstract and logical. For example, in this study, Technological Content Knowledge (TCK) have good teaching and knowledge in finding, evaluating and using online Mathematics applications. While, Valtonen et al. (2019)

Mathematical content knowledge synergistic with technology is dynamic in nature, for example, Technology Content Knowledge (TCK) can select some digital technology to deliver Mathematics High-Level Thinking processes.

Drijvers et al. (2017) argue that Content Knowledge (CK) processes such as visualization of Mathematics relationships with everyday problems should be trained more vigorously and become critical skills in relationships outside of Mathematics Creative Thinking. According to Muhtadi (2019), teachers can teach TPACK to involve technology in the teaching of Mathematics as a function of High-Level Thinking in solving problems outside of Mathematics. In terms of Pedagogical Knowledge (PK), the findings of the study of Borromeo, Elen, & Verschaffel (2019), drawing every thought or idea from a teacher about the pedagogical process is essential to make teachers think outside the box, use imagination, reason and prioritize more challenging activities in classroom teaching. Therefore, Creative teaching would not work if teachers do not have TPACK skills. This situation is supported by the High-Level Thinking possessed.

Structural Equation Model (SEM)

The formation of SEM requires data screening conducted through EFA analysis, pooled CFA factor analysis, validity index, reliability and goodness of fit index that are acceptable for all instruments. In this study, we refers to two modeling steps proposed by Kline (2017): 1) test the measurement model first to get the match with the data and then 2) test the structural model formed by relating the measurement model with enablers change or between all measurement models

Based on Figure 4 shows the SEM analysis obtained RMSEA = 0.118, GFI = 0.901, AGFI = 0.829, CFI = 0.935, TLI = 0.910, NFI = 0.912, and Chi-Sq/df = 3.526. Also, the relationship between HT and TPACK was significant ($\beta = 0.870$; $p = 0.000$; $p < 0.001$). While the findings of the analysis also showed that all indicators for HT construct were significant, AE ($\beta = 0.890$, SE = 0.300, CR = 2.995, $p = 0.003$; $p < 0.05$), and CR ($\beta = 0.783$, SE = 1.124, CR = 4.564, $p = 0.001$; $p < 0.05$). Besides, the analysis for TPACK construct showed significant as well, CK ($\beta = 0.750$, SE = 0.492, CR = 2.430, $p = 0.000$; $p < 0.001$), TC ($\beta = 0.812$, SE = 2.420, CR = 2.421, $p = 0.024$; $p < 0.05$), PK ($\beta = 0.782$, SE = 0.064, CR = 1.909, $p = 0.056$; $p > 0.05$), TPK ($\beta = 0.704$, SE = 0.543, CR = 2.529, $p = 0.011$; $p < 0.05$), TCK ($\beta = 0.690$, SE = 0.627, CR = 2.434, $p = 0.015$; $p < 0.05$), PCK ($\beta = 0.630$, SE = 2.620, CR = 3.097, $p = 0.002$; $p < 0.05$), and TPCK ($\beta = 0.749$, SE = 2.694, CR = 3.099, $p = 0.002$; $p < 0.05$).

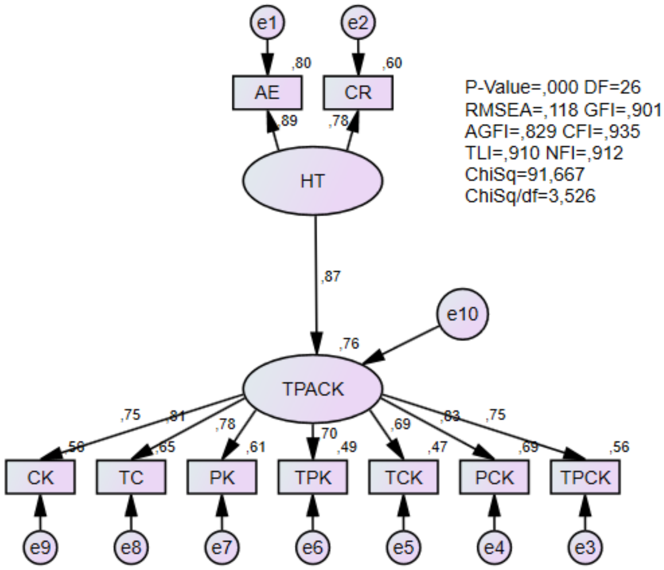

Figure 4. SEM of Relationship between High-Level Thinking and TPACK

The Structural Equation Model shows that the components of TPACK and High-Level Thinking are used for teaching. Also, to understand teaching knowledge integrated with technology, teachers must have the concept of High-Level Thinking (Koehler et al., 2014). The TPACK lies in the intersection space between pedagogical content and technology used in teaching and is not separated from the knowledge domain. The Technological Pedagogy Knowledge (TPK) becomes a prerequisite to teacher planning, reflection, and teaching adaptation that depends on teachers' understanding of High-Level Thinking (Bingimlas, 2009). Thus, it can be explained that High-Level Thinking shows a positive and significant relationship to TPACK because the Mathematical content process synergizes with dynamic technology, dynamic content knowledge to technology applied High-Level Thinking process.

Since various research showed a positive relationship between High-Level Thinking and TPACK, implicitly, High-Level Thinking of Mathematical integrity that focuses on non -routine -shaped Mathematics questions indirectly shapes the TPACK skills. In this regard, Puspitarini and Sunaryo (2018) were found to be less focused on non-routine questions such as application questions, especially questions that integrate Mathematical abilities with their application in daily life. The extreme focus on the need for simple questions is a concern because it not only affects TPACK (Campbell et al., 2014) but is also contrary to the educational goals of the teaching profession in Indonesia itself, which aims to create professional and superior teachers (Arifa & Prayitno, 2019).

One of the factors that can apply the relationship is insufficient attention to basic pedagogical knowledge, teacher misconceptions and lack of teacher sensitivity to the level of difficulty of pedagogical content (Aldama & Pozo, 2017). Whereas, the relationship of pedagogical content knowledge with technological content knowledge, in this case, teachers should build a deep understanding and identify the High-level Thinking and misconceptions of creative thinking (Lamichhane, 2018). However, the findings illustrating that pre-teachers lack the initiative to implement in-depth understanding building on analytical evaluation thinking. It is believed to limit pre-service teachers' opportunities to learn creative thinking and technological content, leading to a less strong relationship between High-Level Thinking and TPACK.

CONCLUSION

Successful learning requires a creative thinking process. Creative thinking skills in problem-solving activities in education are needed to identify problems, see problems from various perspectives and explore ideas used to solve problems. 21st-century learning sees that problem-solving can be solved with the help of technology. Learning with technology becomes an activity in the classroom. Also, by thinking critically, teachers better understand how to use technology most effectively to create meaningful learning. The benefits of using technology accompanied by critical thinking include 1) having many alternative solutions to problems, 2) be a good co-worker, and 3) being more independent in finding solutions. With technology, teachers can solve problems in various ways, and the critical thinking process makes it easier for teachers to see the best way. Besides, to improve learning, especially mathematics learning, it can be done with two skills: higher-order thinking and TPACK. Learning mathematics is one of the main lessons in class and has the main characteristics of structured learning and has a systematic flow. The attributes of existing mathematics learning may support the technology learning process, which also has an orderly system and algorithm. Therefore, it can be explained that in learning mathematics, technology can be used appropriately.

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