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Analysis of Technological Pedagogical and Content Knowledge (TPACK) to the Economics and Accounting Teachers

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Abstract

In this study, a TPACK model was tested which describes the relationship between variables including Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical and Content Knowledge (TPACK). Tests were done that obtain results regarding to the variables influencing TPACK the most. Respondents in this study were 61 economics and accounting teachers in SMA, SMK and MA Negeri Banyumas Regency. This study used a quantitative approach with a questionnaire technique. PLS with Smartpla 3.0 software was used as a analysis tool in this study. Based at the results of studies and data analysis, we can conclude that the variable that had the finest effect on TPACK was Technological Pedagogical Knowledge (TPK), thus the economics and accounting teachers in SMA, MA and SMK must be able to improve their TPK abilities. This is carried out by integrating various appropriate technologies in learning approaches such as learning strategies and designs so it can be able to build new interactions in improving the learning process.

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INTRODUCTION

We are currently in the Era of Industrial Revolution 4.0, where technology is the main basis in our life. Everything becomes limitless with the internet; this makes technology development become faster and more precise. This era will disrupt all fields, including economy, social, culture and education. In this global era, teachers have an important role in creating optimal graduates of millennial generation. Teachers must be able to think digitally so that the learning process will always be *up to date*, one of the ways is the use of technology. Gur & Karamete (2015) states that technology can changes the way we think about education and learning. Importing technology literacy to support learning (Trust, 2018).

In addition to increase the competence of teachers, the use of technology is also an effort to increase the effectiveness and efficiency of the learning process. Gur & Karamete (2015) suggest that technological tools are considered the most effective tools in the educational process, both inside and outside schools. This topic is strengthened in the form of the 2016 Permendikbud No. 22 Government Ordinance on Standards for the Primary and Secondary Education Process. One of the education principles used is the use of information and communication technology to increase the effectiveness and efficiency of learning process.

However, the teacher competencies are still not optimal nowadays. The results of Banyumas Regency Teacher Competency Test in 2019 (UKG) released by the Ministry of Education and Culture showed that the average teacher's ability scored 64,50 (npd.kemdikbud.go.id). This has not yet reached the KKM (minimum score) of UKG set by the government, which is 8,0.

Thus, various efforts to improve teacher competence must continue to be carried out, both pedagogic competence, content and technology. As stated by Koehler, Mishra & Cain (2013) that teaching is a complex practice that requires connected various types of specialized knowledge. It is not enough for a teacher to only be able to master the material, but the most important thing is to be able to convey material with good teaching skills. Especially in today's digital era, teachers are required to have 21st century skills comprehensively to be adaptive to current technological developments. As stated in the research by Akhwani & Rahayu (2021) that the 21st century educational framework has been adjusted to the various competencies needed.

This study aims to identify the results of the analysis of the Technological Pedagogical Content Knowledge (TPACK) to the Economics and Accounting Teachers of Banyumas Regency. Koehler, Shin & Mishra (2011) stated that the TPACK framework has a significant impact on researches and practices in the field of educational technology. If it is proven that all TPACK components have an influence on TPACK, then it can be used as input for the Board of Education Office and the schools to develop the pedagogic, content and technology capabilities of teachers, especially Economics and Accounting teachers.

The integration of teacher knowledge between technology, pedagogic and content components will create new knowledge, it is Technological Pedagogical and Content Knowledge or abbreviated as TPACK (Koehler, Mishra, Kereluik, Shin & Graham, 2014). TPACK is described as a form of multi-integration (Holland & Piper, 2016). TPACK is an interactive relationship model between content, technology and pedagogical knowledge, integration between technology and content knowledge and learning methods and techniques that help students build knowledge better (Koehler & Mishra, 2005; Yanpar Yelken, Sancar Tokmak, zgelen & ncikab, 2013 in Çoban, Akpinar, Baran, Saglam, Ozcan & Kahyaoglu (2016).

Figure 1 shows the three main elements of teacher knowledge, including, content, pedagogy and technology. The three main components of teacher knowledge above interact and produce TCK, PCK, TPK and TPACK (Koehler et al., 2013; Kim et al., 2018). Here's an explanation of each TPACK domain.

***Technological Knowledge* (TK).** Technological knowledge is knowledge on how technology is integrated in learning process and how it can improve the learning strategies and strengthen the material received by students. Technological Knowledge is knowledge related to the use of technology, such as operating computers and relevant software (Chai et al., 2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK Furthermore, TK is also a teacher's knowledge of various technologies that can be integrated into the curriculum (Koehler et al., 2014).

***Pedagogical Knowledge* (PK).** Pedagogical knowledge is knowledge about teaching strategies such as ways to present and formulate material so that it can be easily understood by students. PK is knowledge on how to plan learning, deliver lessons, conditioning the students and convey messages to different individuals (Chai et al., 2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK. PK refers to teachers' knowledge of various educational practices, strategies, and methods for improving student learning (Koehler et al., 2014).

***Content Knowledge* (CK)**. Content knowledge is the understanding of the material that the teacher is teaching (subject-matter knowledge) so teachers have a responsibility in carrying out learning (Koehler et al., 2014). As stated Chai et al (2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK(Chai, C. S., Koh, J. H. L., Tsai, C.-C. & Tan, 2011) that CK is knowledge of the content or subject of certain material such as knowledge of mathematics, language, natural sciences, etc. CK is knowledge that includes the core material to be taught.

***Technological Content Knowledge* (TCK)**. Technological content knowledge is knowledge how to apply technology on a certain subject matter or to use new ways of teaching certain materials. TCK is about how material can be represented by technology such as using computer simulations on certain materials (Chai et al., 2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK. TCK refers to knowledge about the interrelationships between technology and learning materials (Koehler et al., 2014). Understanding how technology and content influence and limit each other. Understanding the impact of technology on learning practice in a particular discipline is important for developing the right technology tools to meet educational goals (Koehler et al., 2013).

***Pedagogical Content Knowledge* (PCK)**. Pedagogical content knowledge is pedagogical knowledge such as how to teach and plan a learning process that can be used and suitable for teaching subject matter. PCK is knowledge about how to display and present material that make it understandable (Chai et al., 2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK. PCK according to Shulman's ideas in 1986 and 1987 in Koehler et al (2013) is pedagogical knowledge that is applied in teaching a particular material. The essence of this concept is about the transformation of materials in the educational process. Transformation occurs when the teacher find ways to interpret the material, convey it and adapt it to the student's prior knowledge.

***Technological Pedagogical Knowledge* (TPK).** Technological pedagogical knowledge is knowledge about how technology impacts the teaching and educational process such as how technology supports and hinders design and learning strategies in the classroom. (Chai et al., 2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK. TPK also refers to understanding how education and learning change when a particular technology is used in a particular way (Koehler et al., 2013). Including the ability to find out the pedagogical affordability and the constraints of the technological tools used in the design and learning strategies.

***Technological Pedagogical Content Knowledge* (TPACK)**. TPACK is knowledge of how to make it easier for students to learn certain materials through an educational and technological approaches. TPACK is knowledge that facilitates student learning in certain matter using a pedagogical and technological approach (Chai et al., 2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK. TPACK is an interaction between material knowledge, pedagogy and technology. As the foundation of effective technology-based education, TPACK provides an understanding of the use of technology, the use of technology in teaching materials, and the overcoming of student problems, student prior knowledge, and the expression of concepts in the development of knowledge (Koehler et al., 2013).

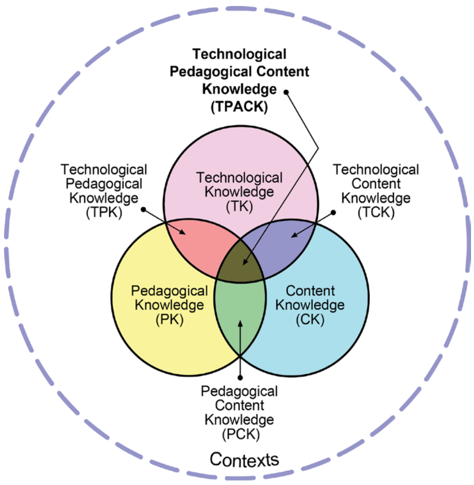

Figure 1. Components of the TPACK Framework. Source: http://tpack.org/

Koehler and Mishra's approach emphasizes the relationship and interaction between these three elements (Figure 1). For example, considering pedagogy and content together, will result in Pedagogical Content Knowledge (PCK). Technology and content together produce Technological Content Knowledge (TCK). Technology and pedagogy together become Technological Pedagogical Knowledge (TPK). By considering these three elements, we can conclude the what Technological Pedagogical Content Knowledge (TPACK). The following figure is the conceptual framework based on the model that is built as a basis to formulate hypotheses.

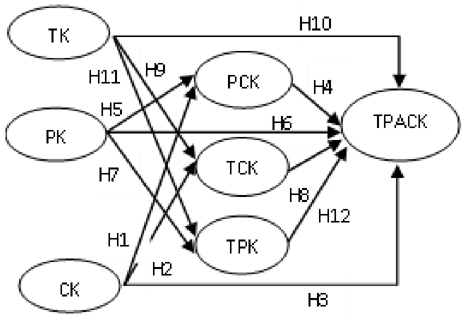

Figure 2. Model of The Study
Source : Data Proses (2020)

Information:
TK : *Technological Knowledge*
PK : *Pedagogical Knowledge*
CK : *Content Knowledge*
TPK : *Technological Pedagogical Knowledge*
TCK : *Technological Content Knowledge*
PCK : *Pedagogical Content Knowledge*
TPACK : *Technological Pedagogical and Content Knowledge*

Based on the research model above, the development of the hypothesis is as follows:
H1 : CK has a positive effect to PCK
H2 : CK has a positive effect to TCK
H3 : CK has a positive effect to TPACK
H4 : PCK has a positive effect to TPACK
H5 : PK has a positive effect to PCK
H6 : PK has a positive effect to TPACK
H7 : PK has a positive effect to TPK
H8 : TCK has a positive effect to TPACK
H9 : TK has a positive effect to TCK
H10 : TK has a positive effect to TPACK
H11 : TK has a positive effect to TPK
H12 : TPK has a positive effect to TPACK

METHOD

The study method used in this study was a quantitative approach. The data acquisition technique used was literature studies. The population in this study was all high schools' and Islamic high schools' economics teachers as well as the accounting teachers of state vocational school in Banyumas Regency. A saturated sample was used as the sample masurement. According to Sugiyono (2017), saturation sampling is a sampling technique that uses all members of the population as a sample. In this case, all the populations encountered were samples of this study, with 76 teachers.

A questionnaire was used as the survey method. According to Sugiyono (2013), a survey is a data collection technique performed by asking respondents a series of questions or written statements that need to be answered. The variable measurement scale refers to the Likert Scale, using a scale of 1-5 categories of answers, from strongly agree to strongly disagree. The questionnaire was compiled based on the variables in TPACK, by measuring technology, pedagogy, and teacher learning knowledge using the TPACK questionnaire framework from Chai et al., (2013)efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the basic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK. A total of 31 questions were used in this study, namely TK 4 questions, PK 5 questions, CK 4 questions, TPK 5 questions, TCK 4 questions, PCK 5 questions, and TPACK 5 questions.

In this study, Partial Least Square (PLS) with SmartPLS version 3.0 software was the data analysis technique used to test the hypotheses. One of the advantages of PLS is that it is able to process data with a small sample size (Abdillah & Hartono, 2015). The procedures performed in data analysis using Partial Least Square (PLS) include: (1) structural model (inner model) and path diagram design, (2) measurement model (outer model) design, (3) creating the path diagram, (4) convert path diagram to system of equations, (5) estimate path coefficients, loads and weight, (6) evaluate goodness of fit, and (7) test hypothesis (Ghozali, 2016).

Efforts to survey teachers' TPCK efficacy has yet to identify all seven factors postulated by the framework. This study attempted to validate a TPCK efficacy survey by implementing it on an Asian group of 550 preservice teachers from China, Hong Kong, Singapore and Taiwan. The seven factors underlying the TPCK framework were identified which suggested the research instrument to be valid and reliable. The structural equation model proposed based on the TPCK framework supported eight out of 12 hypotheses about the relationships between TPCK constructs. The results indicate that the positive effects of the ba-

Table 1. Research of Variable Indicators

Variable	Indicator
Technological Knowledge (TK)	Computer technical skills Ease of studying technology Handling technical ICT problems Keep up with technological developments
Pedagogical Knowledge (PK)	The ability to expand students' thinking processes The ability to help students to find the right learning strategy The ability to help students monitor how they learn The ability to help students reflect on their learning strategies Ability to guide students in effective group discussions
Content Knowledge (CK)	Mastering the material Looking like an expert in their field (subject matter expert) In-depth content Self-confidence
Pedagogical Content Knowledge (PCK)	The method of delivering material without the use of technology Overcoming student learning difficulties without using technology Facilitating discussions without using technology Inviting students to solve real problems related to the material without using technology Supporting students managing learning material without using technology
Technological Content Knowledge (TCK)	Using special software related to the subject Knowing the technology that must be used to study the subject matter Using appropriate technology to represent the material being taught. Using special software in the inquiry approach to the subject matter
Technological Pedagogical Knowledge (TPK)	Using technology to introduce real-world problems to students. Through ICT / online learning, able to plan and monitor student learning. Facilitating students through the use of technology in order to be able to build various forms of knowledge representation. Facilitating students to collaborate each other through the use of technology.
Technological Pedagogical and Content Knowledge (TPACK)	Formulate in-depth discussion material topics and facilitate online student collaboration with the right tools. Presenting activities to assist students in representing material using appropriate ICT tools. Make independent learning about the subject matter with appropriate ICT tools. Conduct an inquiry approach to guide students so that the material is easy to understand, using appropriate ICT tools. Designing learning that integrates content, technology and pedagogy appropriately in Student Centered Learning.

Source: Chai et al (2013)

sic knowledge factors of CK, PK, and TK were indirect, occurring through the second layer of knowledge factors (TPK, TCK, and PCK

RESULTS AND DISCUSSION

Based on table 2, it can be seen that there were 24 male respondents with a percentage of 31,6% and 52 female respondents with a percentage of 68,4%. This shows that most of the respondents were female. Judging from the age of the group, most of the respondents were 45-55 years old with a total of 29 people with a percentage of 38,2%. Most of the respondents were bachelor degree graduates, with the total of 59 people with a percentage of 77,6%. Based on the length of teaching experience, most respondents have been teaching for 10-19 years with a total of 28 people with a percentage of 36,8%.

Table 2. Respondent Charateristics

Charateristics	Criteria	Numbers	%
Sex	Male	24	31.6 %
	Female	52	68.4 %
Age	< 25	4	5.3 %
	15 - 20	1	1.3 %
	20 - 35	12	15.8 %
	35 - 45	20	26.3 %
	45 - 55	29	38.2 %
	55 – 65	10	13.2 %
Last Education	Bachelor Degree	59	77.6 %
	Master Degree	17	22.4 %
Length of Teaching Experience	< 5	12	15.8 %
	5 - 9	9	11.8 %
	10 -19	28	36.8 %
	20 – 29	18	23.7 %
	30 – 39	9	11.8 %

Source: Data Proses (2020)

Data analysis was accomplished by analyzing the outer model that connected each indicator with their latent variable. This measurement model test was done through the PLS Algorithm by looking at the results of the indicator validity and construct reliability (convergent and discriminant validity).

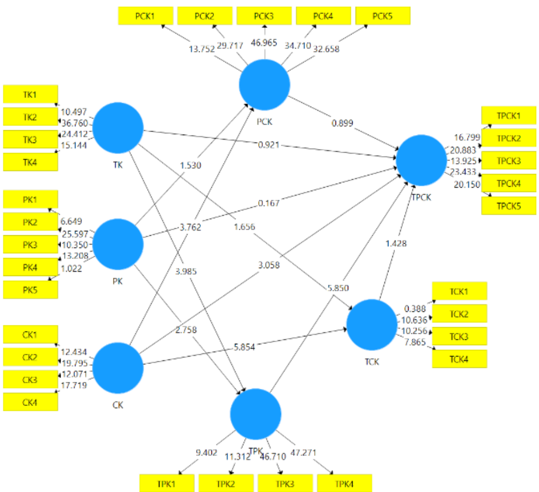

Figure 3. Results PLS
Source: Process Data (2020)

The value of convergent validity is the value of the load factor of the latent variable and its indicators. The validity of the indicator can be seen from the result of Loading Factor (LF) value. To check the effectiveness of the indicator from the result of the load factor (LF) Value. According to Ghozali (2014), the LF indicator value ≥ 0,7 is valid. The outer loading results in table 3 are obtained based on the test results using the SmartPLS 3.0 software.

In the validation test, the total correlation value of the modified items is also called the calculated r value, and the decisions in the validation test are based on the following decision criteria:
If r count > r table, the questionnaire is valid.
If r count < r table, then the questionnaire is invalid.
df = (N-2) = r tabel 0,2242

The validation validity test using the reflex index was scored by comparing the average value of extracted (AVE) square root values of each constructs to the correlation between the constructs and the other constructs in the model. The validity determination is good if the AVE square root score for each constructs is greater than the correlation between that configuration and the other constructs in the model (Ghozali, 2014).

The evaluation of the reliabilty value of construct is measured using the value, Cronbach's alpha and composite reliability. If the Cronbach's alpha value is > 0,6 and composite reliability is > 0,7, the construct is declared reliable. Data that has composite reliability > 0,7 has high reliability. Data with a combined reliability greater than 0,7 is more reliable. All variables have Cronbach's alpha value > 0,6 and composite reliability > 0,7 on the table 4, except for the TCK variable, which has Cronbach's alpha value < 0,6. So, this indicator has a low reliability value.

Inner Model Analysis

R2

Inner model analysis is a structural model to connect latent variables. This structural model test can be done in three ways, including; by looking at R2, Q2 and GoF. This is done by a bootstrapping procedure.

Table 3. *Outer Loadings Results*

Variable	CK	PCK	PK	TCK	TK	TPACK	TPK	Result
CK1	0.737							Valid
CK2	0.828							Valid
CK3	0.785							Valid
CK4	0.796							Valid
PCK1		0.877						Valid
PCK2		0.923						Valid
PCK3		0.930						Valid
PCK4		0.929						Valid
PCK5		0.928						Valid
PK1			0.705					Valid
PK2			0.863					Valid
PK3			0.776					Valid
PK4			0.817					Valid
PK5			-0.216					Invalid
TCK1				-0.082				Invalid
TCK2				0.790				Valid
TCK3				0.781				Valid
TCK4				0.767				Valid
TK1					0.772			Valid
TK2					0.905			Valid
TK3					0.880			Valid
TK4					0.788			Valid
TPCK1						0.806		Valid
TPCK2						0.818		Valid
TPCK3						0.766		Valid
TPCK4						0.851		Valid
TPCK5						0.833		Valid
TPK1							0.695	Invalid
TPK2							0.750	Valid
TPK3							0.906	Valid
TPK4							0.905	Valid

Resource : Data Proses (2020)

Table 4. Result of AVE dan AVE Square Root, Cronbach's Alpha, dan Composite Reliability

	Average Variance Extracted (AVE)	AVE Square Root	Cronbach's Alpha	Composite Reliability	
CK	0.620	0.787	0.796	0.867	Reliable
PCK	0.842	0.918	0.953	0.964	Reliable
PK	0.511	0.715	0.613	0.780	Reliable
TCK	0.457	0.676	0.541	0.701	Not reliable
TK	0.702	0.838	0.857	0.904	Reliable
TPACK	0.665	0.815	0.874	0.908	Reliable
TPK	0.671	0.819	0.831	0.890	Reliable

Resource : Data Proses (2020)

Table 5. *R Square Examination Result*

	R Square	R Square Adjusted
PCK	0.141	0.117
TCK	0.411	0.395
TPACK	0.680	0.652
TPK	0.337	0.319

Source: Data Process (2020)

Table 5 shows the values for the variable PCK at 0,117. This means that 11,7% of the variable PCK can be explained by the variables PK and CK, and the remaining 88,3% can be explained by other variables outside the study model. The value of 0,395 for the TCK variable means that 39,5% of the TCK variable can be explained by the TK and CK variables and the remaining 60,5% can be explained by other variables outside the study model.

In addition, the value of 0,652 for the TPACK variable means that 65,2% of the TPACK variable can be explained by the variables TK, PK and CK and the remaining 34,8% can be explained by other variables outside the study model.

Finally, TPK variable value of 0,319 means that 31,9% of the TPK variables can be explained by the TK and PK variables and the remaining 68,1% can be explained by other variables outside the study model.

Q2 Predictive Relevance

In addition to the size of the R-square, evaluation of the PLS model is performed using the prediction relevance of Q2 or the reuse of prediction samples to represent the fitting function by synthesis of cross validation and prediction from observed variables, can also estimations of construct parameters.

The model lacks of predictive relevance when the value of Q2 > 0, and the value of Q2 < 0 (Ghozali & Latan, 2015). Q2 measures how well the observations are generated by the model and parameter estimates. Next, the inner model test by examining the value of Q^2 (predictive relevance). Can use the following formula to calculate Q^2:

$Q^2 = 1\text{-}(1\text{-}R^2)$

$Q^2 = 1 - (1\text{-}\ 0.141)\ (1\text{-}0.411)\ (1\text{-}0.680)\ (1\text{-}0.337)$

$Q^2 = 0.893$

Goodness of Fit Test (GoF)

The last option is to find the Goodness of Fit (GoF) value. The results of the GoF test were obtained by multiplying the average root value of the communalities by the average root value of r-square. In contrast to CB-SEM, the GoF value in PLS-SEM must be searched manually.

$GoF = \sqrt{(AVExR^2)}$

$GoF = \sqrt{(0.638\ x)}\ 0.392$

$GoF = 0.500$

According to Ghozali & Latan (2015), GoF is used to validate the combined performance of the measurement model (outer model) and the structural model (inner model). The range of values from 0-1 and the interpretations is 0 – 0,25 (Small GoF), 0,25 -0,36 (moderate GoF), and more than 0,36 (large GoF). The results of the following GoF calculation is a value of 0,500. Therefore, we can conclude that the large the GoF of the model and the higher the GoF value, the more appropriate in describing the research sample.

Hypothesis Test

Hypothesis testing can be performed by examining the importance of relationships between constructs. The degree of influence between constructs and the interaction effects is measured by the path coefficient value. The path coefficient that has a T statistic value ≥ 1,96 (or rounded up to 2) or has a probability value (p-value) of 0,000 ≤ 0,05, then it is declared as significant. This study used significant value or a confidence level of 95% (α = 0,05).

The original sample value shows a positive or negative relationship between variables, in the other hand T statistic is used to check the significance of the relationship between variables. Following table is the results of the Partial Least Square calculation using the SmartPLS 3.0 software.

The Influence of *Content* on *pedagogical content knowledge*

Table 6 shows that the statistical T value of 3,762 (≥ 1,96) and the p-value of 0,000 (≤ 0,05), this means that the relationship between content knowledge (CK) and pedagogical content knowledge (PCK) is significant. The original sample value is positive, namely 0,442 which indicates that the direction of the relationship between CK and PCK is positive.

Thus, the first hypothesis (H1) which states that content knowledge has an effect on pedagogical content knowledge is **accepted**. However, this study is different from the research of Sumarto (2020) and Gunawan (2018) which state that there is no effect of content knowledge on pedagogical content knowledge.

Table 6. The result of hypothesis test

Hypothesis	Connection	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/ STDEV|)	P Values	Conclusion
H1	CK - > PCK	0.442	0.452	0.118	3.762	0.000	Accepted
H2	CK - > TCK	0.537	0.541	0.092	5.854	0.000	Accepted
H3	CK - > TPACK	0.370	0.358	0.121	3.058	0.002	Accepted
H4	PCK - > TPACK	-0.061	-0.059	0.068	0.899	0.369	Rejected
H5	PK - > PCK	-0.224	-0.227	0.147	1.530	0.127	Rejected
H6	PK - > TPACK	0.014	0.016	0.084	0.167	0.868	Rejected
H7	PK - > TPK	0.269	0.285	0.097	2.758	0.006	Accepted
H8	TCK - > TPACK	-0.156	-0.140	0.109	1.428	0.154	Rejected
H9	TK - > TCK	0.180	0.191	0.109	1.656	0.098	Rejected
H10	TK - > TPACK	0.068	0.065	0.073	0.921	0.357	Rejected
H11	TK - > TPK	0.426	0.430	0.107	3.985	0.000	Accepted
H12	TPK - > TPACK	0.607	0.604	0.104	5.850	0.000	Accepted

Resource: Data proses (2020)

Content knowledge has a positive effect on technological content knowledge

Table 6 shows that the statistical T value is 5,854 (≥ 1,96) and the p-value is 0,000 (≤ 0,05), this means that the relationship between content knowledge (CK) and technological content knowledge (TCK) is significant. The original sample value is positive, which is 0,537 which indicates that the direction of the relationship between CK and TCK is positive.

Thus, the second hypothesis (H2) which states that content knowledge has an effect on technological content knowledge is **accepted**. This study supports Sumarto's research (2020) which states that content knowledge has an effect on technological content knowledge. However, it is different from Gunawan's research (2018) which states that there is no effect of content knowledge on technological content knowledge**.**

Content knowledge has a positive effect on technological pedagogical content knowledge

Table 6 shows that the T statistical value is 3,058 (≥ 1,96) and the p-value is 0,002 (≤ 0,05), this means that the relationship between content knowledge (CK) and technological pedagogical and content knowledge (TPACK) is significant. The original sample value is positive, which is equal to 0,370, which indicates that the direction of the relationship between CK and TPACK is positive.

Thus, the third hypothesis (H3) which states that content knowledge has an effect on technological pedagogical content knowledge is **accepted**. This study supports the research of Sumarto (2020) and Gunawan (2018) which states that there is an effect of content knowledge on technological pedagogical content knowledge.

Pedagogical content knowledge has a positive effect on technological pedagogical content knowledge

Table 6 shows that the T statistical value is 0,899 (≤ 1,96) and the p-value is 0,369 (≥ 0,05), this means that the relationship between pedagogical content knowledge (PCK) and technological pedagogical and content knowledge (TPACK) is not significant. The original sample value is positive, which is -0,061 indicating that the direction of the PCK and TPACK relationship is negative.

Thus, the fourth hypothesis (H4) which states that pedagogical content knowledge affects technological pedagogical and content knowledge is **rejected**. In contrast to the research of Sumarto (2020) and (Gunawan, 2018) which states that pedagogical content knowledge has an effect on technological pedagogical content knowledge.

Pedagogical knowledge has a positive effect on pedagogical content knowledge

Table 6 shows that the statistical T value of 1,530 (≤ 1,96) and a p-value of 0,127 (≥ 0,05), this means that the relationship between pedagogical knowledge (PK) and pedagogical content knowledge (PCK) is not significant. The original sample value is negative, which is equal to -0,224 indicating that the direction of the relationship between PK and PCK is negative.

Thus, the fifth hypothesis (H5) which states that pedagogical knowledge has an effect on pedagogical content knowledge is **rejected**. This research is different to Gunawan (2018) and (Sumarto, 2020) which state that there is a positive effect of pedagogical knowledge on pedagogical content knowledge.

Pedagogical knowledge berpengaruh positif terhadap technological pedagogical and content knowledge

Table 6 shows that the T statistical value is 0,167 (≤ 1,96) and the p-value is 0,868 (≥ 0,05), this means that the relationship between pedagogical knowledge (PK) and technological pedagogical and content knowledge (TPACK) is not significant. The original sample value is positive, which is equal to 0,014 indicating that the direction of the PK and TPACK relationship is positive.

Thus, the sixth hypothesis (H6) which states that pedagogical knowledge has an effect on technological pedagogical and content knowledge is **rejected.** This study supports the research of Sumarto (2020) and Gunawan (2018) which state that pedagogical knowledge has no effect on technological pedagogical and content knowledge.

Pedagogical knowledge* berpengaruh positif terhadap *technological pedagogical knowledge

Table 6 shows that the T statistical value is 2,758 (≥ 1,96) and the p-value is 0,006 (≤ 0,05), this means that the relationship between pedagogical knowledge (PK) and technological pedagogical knowledge (TPK) is significant. The original sample value is positive, equal to 0,269 which indicates that the direction of the relationship between PK and TPK is positive.

Thus, the seventh hypothesis (H7) which states that pedagogical knowledge affects technological pedagogical knowledge is **accepted**. This study supports the research of Sumarto (2020) and Gunawan (2018) which states that pedagogical knowledge has an effect on technological pedagogical knowledge.

Technological content knowledge has a positive effect on technological pedagogical and content knowledge

Table 6 shows that the T statistical value is 1,428 (≤ 1,96) and the p-value is 0,154 (≥ 0,05), this means that the relationship between technological content knowledge (TCK) and technological pedagogical and content knowledge (TPACK) is not significant. The original sample value is negative, which is equal to -0,156 which indicates that the direction of the relationship between TCK and TPACK is negative.

Thus, the eighth hypothesis (H8) which states that technological content knowledge affects technological pedagogical and content knowledge is **rejected**. This study supports the research of Sumarto (2020) and (Gunawan, 2018) which states that technological content knowledge has no effect on technological pedagogical and content knowledge**.**

Technological knowledge has a positive effect on technological content knowledge

Table 6 shows that the T statistical value is 1,656 (≤ 1,96) and the p-value is 0,098 (≥ 0,05), this means that the relationship between technological knowledge (TK) and technological content knowledge (TCK) is not significant. The original sample value is positive, equal to 0,180 indicates that the direction of the relationship between TK and TCK is positive.

Thus, the ninth hypothesis (H9) which states that technological knowledge has an effect on technological content knowledge is **rejected**. This study is different from the research of Sumarto (2020) and Gunawan (2018) which states that technological knowledge has an effect on technological content knowledge.

Technological knowledge* has a positive effect on *technological pedagogical and content knowledge

Table 6 shows that the T statistical value is 0,921 (≤ 1,96) and the p-value is 0,357 (≥ 0,05), this means that the relationship between technological knowledge (TK) and technological pedagogical and content knowledge (TPACK) is not significant. The original sample value is positive, equal to 0,068 indicating that the direction of the relationship between TK and TPACK is positive.

Thus, the tenth hypothesis (H10) which states that technological knowledge has an effect on technological pedagogical and content knowledge is **rejected**. This study supports the research of Sumarto (2020) and Gunawan (2018) which states that technological knowledge has no effect on technological pedagogical and content knowledge.

Technological knowledge* has a positive effect on *technological pedagogical knowledge

Table 6 shows that the statistical T value is 3,985 (≥ 1,96) and the p-value is 0,000 (≤ 0,05), this means that the relationship between technological knowledge (TK) and technological pedagogical knowledge (TPK) is significant. The original sample value is positive, equal to 0,426 indicating that the direction of the relationship between TK and TPK is positive.

Thus the eleventh hypothesis (H11) which states that technological knowledge has an effect on technological pedagogical knowledge is **accepted**. This study supports the research of Sumarto (2020) and Gunawan (2018) which states that technological knowledge has an effect on technological pedagogical knowledge.

Technological pedagogical knowledge* has a positive effect on *technological pedagogical content knowledge

Table 6 shows that the T statistical value is 5,850 (≥ 1,96) and the p-value is 0,000 (≤ 0,05), this means that the relationship between technological pedagogical knowledge (TPK) and technological pedagogical and content knowledge (TPACK) is significant. The original sample value is positive, which is equal to 0,607 indicating that the direction of the relationship between TPK and TPACK is positive.

Thus, the twelfth hypothesis (H12) which states that technological pedagogical knowledge has an effect on technological pedagogical and content knowledge is **accepted**. This research supports Sumarto's research (2020) which states that technological pedagogical knowledge has an effect on technological pedagogical and content knowledge, but it is in contrast to Gunawan's research (2018) who states that technological pedagogical knowledge has no effect on technological pedagogical and content knowledge.

CONCLUSION

Based on the results of research testing and discussion that has been stated, here are the following conclusions: First, content knowledge has a positive effect on pedagogical content knowledge. Second, content knowledge has a positive effect on technological content knowledge. Third, content knowledge has a positive effect on technological pedagogical and content knowledge. Fourth, pedagogical content knowledge has no positive effect on technological pedagogical and content knowledge. Fifth, Pedagogical knowledge does not have a positive effect on pedagogical content knowledge. Sixth, pedagogical knowledge has no positive effect on technological pedagogical and content knowledge. Seventh, pedagogical knowledge has a positive effect on technological pedagogical knowledge. Eighth, technological content knowledge has no positive effect on technological pedagogical and content knowledge. Ninth, technological knowledge has no positive effect on technological content knowledge. Tenth, technological knowledge has no positive effect on technological pedagogical and content knowledge. Eleventh, technological knowledge has a positive effect on technological pedagogical knowledge. Twelfth, technological pedagogical knowledge has a positive effect on technological pedagogical and content knowledge.

Based on the results of the analysis and testing of research results, the factor that gives the greatest contribution to the TPACK model is the variable technological pedagogical knowledge, thus teachers must continue to improve their technological pedagogical abilities. Teachers must continue to improve technology-based teaching methods in their learning. This effort is carried out by integrating various appropriate technologies in learning approaches such as learning strategies and designs so as to be able to build new interactions in the learning process. In addition, it is expected to be able to improve the learning process.

This research still has some lack, including the use of a small sample due to the focus on the real number of teachers in SMA and SMK Negeri of Banyumas Regency. This causes the research results have not been able to generalize the overall condition in various places. However, the results of this research theoretically and practically can contribute to the development of the world of education. In addition, the results of this study can also be used as a reference for future research with a wider coverage of the sample area and the addition of other variables that are more comprehensive.

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