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## Analysis of Kindergarten Teachers on Pedagogical Content Knowledge

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**Abstract:** This research aims to determine the relationship between the seven components of Pedagogical Content Knowledge possessed by kindergarten teachers. The animal theme was chosen to determine the pedagogical content knowledge component profile of 30 kindergarten teachers, with data obtained through classroom observation, interviews, learning plan documentation. This study employed a mixed-method design, a type of sequential explanatory research with the structural equation modeling-partial least squares and descriptive tests used to quantitative and qualitatively analyze the data obtained. The result showed that: the relationship between the components is specified in the context of using themes to learn in the kindergarten; analysis of the relationships between the components is carried out separately, such as the relationship of all 7 (seven) components to 1 (one) pedagogical content knowledge component of kindergarten teachers; Orientation of teaching has the strongest relationship with Knowledge of Instructional Strategies for Teaching; Knowledge of assessment of early childhood education has the weakest relationship with knowledge of early childhood education subject matter; pedagogical content knowledge components for kindergarten teachers that are often found and associated with other components in a learning episode are orientation of teaching, knowledge of early childhood education curriculum, and knowledge of instructional strategies; there are pedagogical content knowledge component for kindergarten teacher that often found and connection with other component in a learning episode.

**Keywords:** *Pedagogical content knowledge, kindergarten, teachers.*

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### Introduction

Kindergarten teachers for children between the ages of 4-6 years need to possess different competencies from those in the elementary and secondary school levels (Seefeldt & Wasik, 2006). The Early Childhood Education Association, which is spread worldwide, also agrees that they need to understand the characteristics of children, able to interact with children (Fukkink et al., 2019), as well as the techniques used to achieve optimal development in all aspects of growth (National Association for the Education of Young Children, 2019). This cannot be separated from the important role of kindergarten as the first person other than parents (Ersan, 2020), which involves stimulating the child's development. Eurydice (2009) stated that to become a kindergarten teacher, a person needs to be educationally oriented, with competencies and qualifications to prepare children for lifetime learning. In fact, in some countries such as Denmark, England, Finland, Norway, Sweden, and USA they need to have certain competencies that consist of 6 dimensions namely general pedagogical competencies, specific content competencies, special competencies, play competencies, children's perspective competencies, collaborative and social competencies, besides that determined by the different local governments (Lillvist et al., 2014).

Early childhood education, which consists of pre-school and kindergarten (Seefeldt & Wasik, 2006), is an initial milestone that determines children's development in the future (Morrison, 2007). Subsequently, they experience the most important learning periods that tend to affect their future when they are between the ages of 0-8 years (Aljojo et al., 2019). Furthermore, children within the age range of 0-8 years (particularly between the ages 4-6) tend to develop different characteristics in elementary or middle school (Dodge & Colker, 2001). They tend to be active, highly curious, like adventures, and absorb information with extraordinary speed (Figueiredo et al., 2018; Wood, 2005).

According to Dodge & Colker (2001); Mei-ju et al., (2014) early childhood usually learn by playing, observing simple concepts and using these to develop more complex ideas, as well as concrete and literal knowledge, additionally, this

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has an impact on the formation of distinctive learning in kindergarten. Bautista et al., (2016) reported that the characteristics of teaching in kindergarten involves the following (1) a holistic approach to development and learning, (2) integrative and interactive learning, (3) children as curious, active and competent students, (4) adults supporters that are interested in learning.

Murray et al., (1979) stated that teaching children aged 4-6 years are a complicated thing that tends to have a significant impact on their development in the future. In accordance with this, Zhang (2015) stated that the pedagogical task of kindergarten teachers is different from that of those in primary and secondary education because, during teaching, they do not merely convey knowledge related to learning content. Park and Chen (2012) reported that to accommodate diverse students' interests, understandings, abilities, and experiences, teachers need to develop specific knowledge that exceeds that in accordance with the learning content. They also need to develop the knowledge of being able to determine strategies and learning contexts that are appropriate for the students. According to Shulman (1987) a combination of this knowledge is referred to as Pedagogical Content Knowledge (PCK).

In teaching practice, PCK is the main determinant as well as the center of curriculum and strategy decision making by teachers (Jones & Moreland, 2017). However, Shulman (1987) stated that PCK interpreted the process of impacting knowledge by understanding various topics or themes, as well as specific integrated problems to students with various interests and abilities. On the contrary, (Lee, 2010) reported that it includes the interpretation and conveyance of certain subjects to students in an understandable way. This explanation reinforces the fact that kindergarten teachers need to have knowledge of PCK and be able to apply it during teaching.

Park and Chen (2012) stated that the PCK analysis is the relationship between components which are possessed by kindergarten teachers on specific themes or topics. The results from the analysis are required to plan, improve, and implement effective strategies in teaching groups of students in certain contexts (Loughran et al., 2004). According to (Lee, 2010) the involvement of the PCK component tends to affect the delivery of materials provided by the tutor. However, there were still few studies that focused on early childhood teachers. It is essential to conduct this analysis, particularly in kindergarten teachers that have unique characteristics in teaching (Zhang, 2015). Previous researches focus on PCK components in science, mathematics, and languages taught in high school and higher education for prospective teachers (Abell, 2008). Furthermore, studies based on the in-depth analysis in accordance with the interaction of this component in early childhood educators, particularly in the kindergarten (TK), still needs to be carried out (Figueiredo et al., 2018).

Subsequently, PCK research on kindergarten teachers previously conducted produced several analyzes such as 1) it only focused on individual components (Lee, 2010; Lee, 2017), 2) it also focused on mathematics (Lee, 2010; Lee, 2017; McCray & Chen, 2012), language (Jordan et al., 2018), and psycho-social (Kankam & Abroampa, 2015). Based on these considerations, it is necessary to conduct another research that is able to describe the interaction between PCK components possessed by kindergarten teachers and focus on content knowledge, which is interpreted as a theme, not a field of science.

In this research, the animal theme is chosen as the content in order to discover the relationship between the PCK components possessed by kindergarten teachers. In preliminary studies, children are familiar with animal themes, however, most teachers only focus on the students' cognitive abilities (Gjertrud et al., 2016). Although in kindergarten, children do not only develop scientific and cognitive abilities, they also develop other skills such as language, social, physical motor, and art (Lan & Fielding, 2012; Martella & Connors-Tadros, 2014). In the development of each of these capabilities, different strategies are required (Seefeldt & Wasik, 2006). Therefore, animal themes are used to analyze the relationship between PCK components of kindergarten teachers in developing all the abilities of early childhood (4-6 years).

The results from the analysis are certainly required not only for the development of kindergarten teachers that are in the system; however, it is also needed by prospective early childhood tutors. Kankam & Abroampa (2015) stated that they need to understand the content, pedagogy, curriculum, and how they interact. It also provides opportunities for prospective teachers to examine the objectives of various curriculum components during their participation in Field Experience Practices (PPL) or internship program (Kankam & Abroampa, 2015). In addition, they also need to focus on mastering effective teaching behavior (Zakaria et al., 2019) and must understand the knowledge framework contained in the integration of PCK components (Abell, 2008).

This research analyzes the interaction of the different PCK components used in delivering in-depth results, and it is also used as a guide for teachers and prospective kindergarten educators. Co-Re measurement tools are used to measure the interaction between the components which were integrated into a pentagon PCK design. This research conceptually used the pentagon design combined with 2 PCK map models (Magnusson et al., 2002; Park & Chen, 2012). The purpose of this study was to analyze the PCK components possessed by kindergarten teachers using the pentagon model, namely 1) Orientation of Teaching (OT), 2) Knowledge of ECE Subject Matter (KESM), 3) Knowledge of Student's Understanding in Learning (KSU), 4) Knowledge of ECE Curriculum (KEC), 5) Knowledge of Context (KofC), 6) Knowledge of Assessment of ECE (KAE), 7) Knowledge of Instructional Strategies for Teaching (KIST).

## Literature Review

### *Pedagogical Content Knowledge*

Pedagogical Content Knowledge (PCK) is a concept to represent teachers' professional knowledge and has been widely used in teacher knowledge literature (Fernandez, 2014). Newsome et al., (2019) revealed that the point of PCK is the way the subject matter is changed for teaching and this happens when educators interpret the subject matter and find different ways to represent it and make it accessible to students according to the context of the material, learning theme, or field of study.

The PCK was firstly initiated by Shulman as a form of knowledge for specific teaching to the field of study. However, recent research found that the PCK has a more specific nature on each topic or theme in the field of study (Hashweh, 2005). It includes how to interpret a particular subject and transfer it to students in the form of knowledge that is easily understood by them (Lee, 2017; Wu et al., 2019).

Studies on PCK are still developing and make it a complex and interesting teaching variable to be analyzed according to the field of study or the topic that is being taught (Wu et al., 2019). Even Shulman's concept of PCK has developed into several PCK models with the addition of PCK components or outlining existing components (Park & Chen, 2012). The studies of PCK that focus on the relationship and development among PCK components are based on the concept that PCK is an integral part of the integration among components (Abell, 2008). The relationship among the PCK components produces a PCK model in the field of science and language studies (Fernandez, 2014).

The results of the study on the relationship among components indicate that there are different interactions of each (Park & Chen, 2012; Suh & Park, 2017). It is influenced by inherent factors possessed by research subjects, including the teachers' educational background, teachers' teaching experience(s), and the field of study (Fernandez, 2014; Lee, 2017). The relationship among PCK components is also the basis for the ever-evolving PCK components and it needs to be further elaborated. The PCK components consist of orientation of teaching (OT), knowledge of ECE subject matter (KESM), knowledge of student's understanding in learning (KSU), knowledge of ECE curriculum (KEC), knowledge of context (KofC), knowledge of assessment of ECE (KAE), and knowledge of instructional strategies for teaching (KIST) (Magnusson, Obispo, et al., 2002; Park & Chen, 2012).

### *Pedagogical Content Knowledge of Kindergarten Teachers*

The pedagogical duties of early childhood teachers require a different knowledge base in primary and secondary education (Zhang, 2015). The pedagogical knowledge of early childhood teachers is one of the determinants of success in learning (Figueiredo et al., 2018). Inan (2010) revealed that the factors that affect the success of early childhood education include the teachers' competence, material, methods, learning strategies, the suitability of lessons with the level of child development, and environment designed by teachers so that the children are able to explore (Dejonckheere et al., 2016). All of these factors are part of the PCK components (Aksu & Kul, 2017; Inan, 2010; Zhang, 2015).

The PCK studies for kindergarten conducted by previous researchers have resulted in several analyzes related to the results of PCK studies, including 1) The study focused on individual PCK components only (Lee, 2010; Lee, 2017) and 2) The study focused on mathematics ( Lee, 2010; Lee, 2017; Park & Chen, 2012), science (Alexander, 2016), and psychosocial field (Kankam & Abroampa, 2015). Accordingly, PCK studies in Kindergarten teachers still focus on the field of early childhood knowledge, not focus on the themes and relationship among the PCK components.

## Methodology

### *Research Design*

This study employed a mixed-method design, a type of sequential explanatory research. According to Creswell (2011), this type of study is used to describe research results from theory or facts obtained in the field by using two methods, quantitative and qualitative analysis. The purpose of this research is to determine the relationship between the 7 PCK components, namely 1) orientation of teaching (OT), 2) knowledge of ECE subject matter (KESM), 3) knowledge of student's understanding in learning (KSU), 4) knowledge of ECE curriculum (KEC), 5) knowledge of context (KofC), 6) knowledge of assessment of ECE (KAE), 7) knowledge of instructional strategies for teaching (KIST). This study is focused on analyzing the relationships between the PCK components adapted and modified using the pentagon model derived from science teachers (Magnusson, et al., 2002; Park & Chen, 2012).

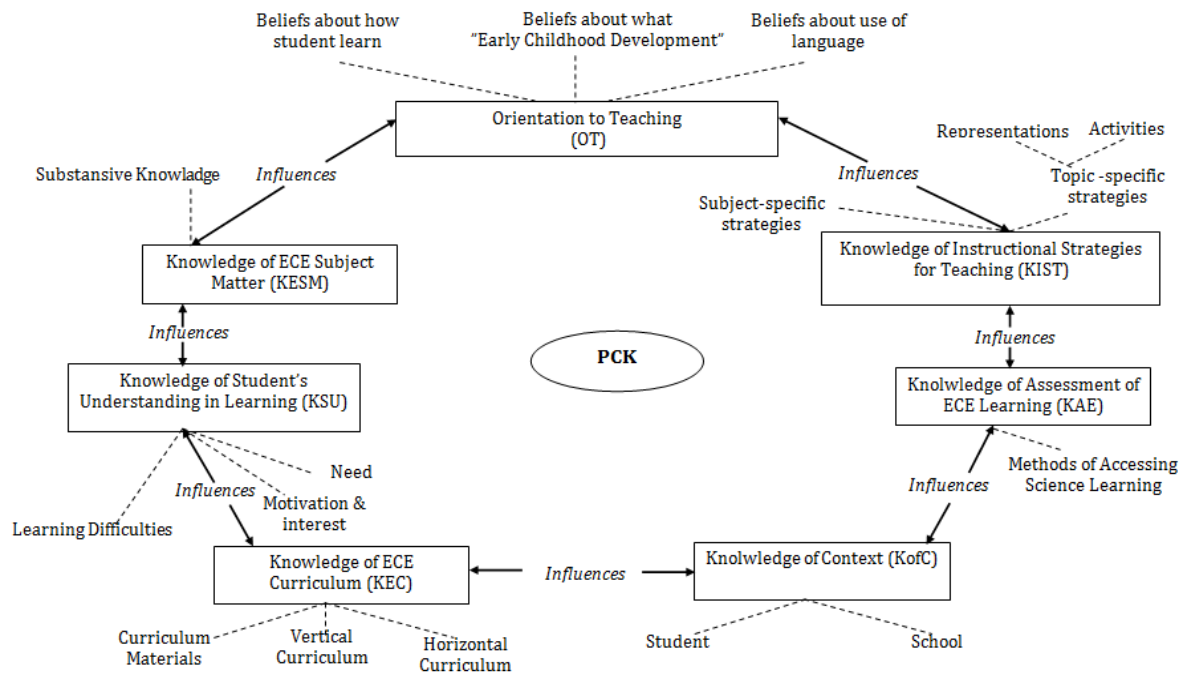


Figure 1. Modified PCK Design for Kindergarten Teachers

The PCK model in Figure 1 is an adaptation and modification of the science teacher pentagon model in the article (Magnusson, et al., 2002; Park & Chen, 2012). Each component consists of different sub components. Descriptions of each PCK component possessed by kindergarten teachers are shown in Figure 1 as follows.

Table 1: Description of the PCK Components of Kindergarten Teachers

No	Code	Variable (PCK component of kindergarten teachers)	Description
1	OT	Orientation of Teaching	This code shows the respondents' answers in accordance with their beliefs concerning early childhood learning, the themes conveyed, and the language used in impacting it.
2	KESM	Knowledge of Early Childhood Education (ECE) Subject Matter	This code shows the respondents' answers in accordance with the material that needs to be delivered during the development of early childhood abilities.
3	KSU	Knowledge of Student's Understanding in Learning	This code shows respondents' answers based on the knowledge of difficulties encountered during the development of early childhood abilities.
4	KEC	Knowledge of Early Childhood Education (ECE) Curriculum	This code shows the respondents' response in accordance with the application of knowledge concerning the material and the relationship of the curriculum in early childhood learning.
5	KofC	Knowledge of Context	This code shows the respondents' answers based on the application of knowledge regarding the characteristics of early childhood faced in the school where they are taught.
6	KAE	Knowledge of Assessment of Early Childhood Education	This code shows the respondents' responses related to the application of knowledge regarding the assessment methods used in measuring the achievement of early childhood abilities developed.
7	KIST	Knowledge of Instructional Strategies for Teaching	This code shows the respondents' answers based on the application of knowledge concerning the learning strategies used in conveying the theme.

The components in table 1 are the main components of PCK, which consist of: 1) orientation of teaching (OT); 2) knowledge of ECE subject matter (KESM); 3) knowledge of student's understanding in learning (KSU); 4) knowledge of ECE curriculum (KEC); 5) knowledge of context (KofC); 6) knowledge of assesment of ECE (KAE); 7) knowledge of instructional strategies for teaching (KIST). This is inseparable from the research focus which only analyzed the relationship among the main components in the PCK of kindergarten teachers that had been adapted from the pentagon model.

Based on the analysis of the relationship between these components, it seems as though they largely contribute to the development of learning in kindergarten. The hypothesis in this study are: 1) KESM, KSU, KEC, KofC, KAE, and KIST have positively effect on OT; 2) KSU, KEC, KofC, KAE, KIST, and OT have positively effect on KESM; 3) KESM, KEC, KofC, KIST, and OT have positively effect on KSU; 4) KESM, KSU, KofC, KAE, KIST and OT have positively effect on KEC; 5) KESM, KSU, KEC, KAE, KIST, and OT have positively effect on KofC; 6) KESM, KSU, KEC, KofC, KIST, and OT have positively effect on KAE ; 7) KESM, KSU, KEC, KofC, KAE, and OT have positively effect on KIST.

#### *Sample and Data Collection*

The research subjects consisted of 30 female kindergarten teachers with different educational backgrounds and teaching experiences in the entire Malang Raya. The research sample was obtained using a proportional random sampling technique and based on the characteristics of the research subject. This is consistent with the previous research that the teachers can consider the characteristics of research subjects that affect the development of PCK (Karal & Alev, 2016; Keller et al., 2017; Lee, 2010). A total of 9 teachers (30%) had a Bachelors' degree in Early Childhood Education , while 13 (43%), 1 (3.3%), and 2 (6.7%), graduated from senior high school/ Vocational High School / Islamic High school, Kindergarten Teacher Education course, and Diploma of Kindergarten Teacher Education. Furthermore, 5 of the coaches (17%) had a bachelors' degree in Engineering, Mathematics, and Accounting. In accordance with the teaching experience, 7 teachers (23.3%) had taught for 1-4 years, another 7 (23.3%) had spent 5-8 years, 2 of the tutors (6.7%) had been teaching for 9-12 years, in addition, 7 (23.3%) have practiced for 13-16 years, 3 educators (10%) had spent 17-20 years teaching, 2 of the coaches had spent (6.7%) 21-24 years, while the remaining 2 (6.7%) have been in service for more than 24 years but less than 33 years

In identifying the relationships between PCK components, this research employed instruments stated by Nilsson & Loughran (2012) its indicators and the Co-Re instrument were reported by (Bertram, 2014; Loughran et al., 2004). The first instrument was used to observe the components that emerged when teachers taught and were involved in learning, while the second tool Co-Re is used to strengthen the quantitative data obtained. The first instrument has been through the process of reliability and statistical validation testing, which was carried out by early childhood education content experts. On the contrary, only a validation test was conducted on the second tool by professionals, this is due to the fact that the Co-Re instrument has been used in previous studies and has shown good results in stating the PCK that is possessed by teachers at various levels of education (Bertram, 2014; Eames et al., 2011; Loughran et al., 2004; Nilsson & Karlsson, 2019; Kennedy et al., 2015).

There are seven PCK components in the first component in which each indicator is based on the development of the instrument from the Loughran PCK indicator (Loughran et al., 2004). In the first instrument there are 7 PCK components with their respective indicator. The answer consists of 5 (five) choices based on the results from the observation conducted during the process of learning by the teacher. The choice of answers employed a Likert scale, consisting of strongly agree (ss), agree (s), doubt (r), disagree (ts), strongly disagree (sts), and this lead to the production of a quantitative data. The instrument was tested, and the validity and reliability test results were obtained as follows.

*Table 2. Instrument Validity Test Results*

Item	Variable (PCK component)	r count
1	OT1	0.841
2	OT2	OT
3	OT3	0.962
4	KESM 1	KESM
5	KESM 2	0.611
6	KSU1	0.717
7	KSU2	KSU
8	KSU3	0.789
9	KEC1	0.858
10	KEC2	KEC
11	KEC3	0.811
12	KofC1	KofC
13	KofC2	0.932
14	KAE1	KAE
15	KAE2	0.852
16	KIST1	KIST
17	KIST2	0.853

Table 2 presents the result of the PCK instrument validity test for each component. The table shows that the calculated  $r$  values of all PCK components are higher than  $r$  table of 0.29, thus it means that the PCK instrument is valid and suitable to use as a research instrument for the relationship of teachers' PCK components.

Table 3. Instrument Reliability Test Results

Variable (PCK component)	Cronbach's Alpha ( $\alpha$ )
7	0.757

This is further strengthened by the results from the instrument reliability test at table 3, which shows the value ( $\alpha$ )  $> .6$ , which means that it is reliable. The second tool, Co-Re, produced descriptive data in the form of interviews. The results from the expert validation test of the Co-Re instrument lead to several adjustments in its content. One of the changes is observed in the first question, on the original Co-Re instrument which stated "What is your purpose in teaching this idea to students?" adjusted to, "What are your purposes for teaching themes in the fields of developing religious and moral values (NAM), social emotional (SE), language (B), cognitive (K), physical motor (FM), and arts (S) to early childhood (AUD)?" The outcome of this tool is used to strengthen the results from the data on the first instrument.

Data collection is carried out through several methods, namely 1) observation, 2) Interview, and 3) documentation. All these methods need to be structured, before, during, and after learning, because PCK components appear in planning, interactive, and post-active teaching (Hashweh, 2005). Observations are made while learning is ongoing, particularly on animal themes. During this procedure, the PCK components that were evident in each learning process were identified by using the first instrument. Interviews with kindergarten teachers were carried out before and after the learning process, however, the Co-Re instrument was used after the tutor had conducted the learning process. Additionally, the documentation was in the form of photos, while data on the learning plan documents consist of both weekly learning plan (RKM) and daily learning plan (RKH).

#### Analyzing of Data

The PCK scores are calculated to assess the relationships of the components possessed by the kindergarten teachers. The data analysis for the hypothesis testing employed a Structural Equation Modeling-Partial Least Squares SEM PLS assisted SMART PLS correlation test. SEM PLS is a statistical test used to analyze non-parametric research data with a sample size of less than 100 (Awang et al., 2015). The data, that are analyzed using SEM PLS, do not also require a data normality test as a prerequisite for analysis (Hair et al., 2017). In this study, before the hypothesis was tested, the following prerequisite analysis which consists of the construct validity test, item reliability test, homogeneity test, and data normality test Jackson et al., (2009) was carried out. This is due to the fact that it is vulnerable to have a high error value in testing correlation data with a sample of less than 100. Every quantitative data obtained in this study was analyzed using SMART PLS. Meanwhile, the qualitative data were analyzed to show the evidence and reasons for the weak relationship between the components of PCK possessed by kindergarten teachers. The qualitative data of this study were analyzed in four stages, such as data condensation, data presentation, conclusion drawing, and verification.

The research data obtained from the first instrument were analyzed using SEM PLS, which included four stages: 1) convergent and discriminant validity tests; 2) variable reliability test (PCK components); 3) hypothesis test; and 4) evaluation of the structural model. The convergent validity test can be determined based on the results of the Average Variance Extracted (AVE) and outer loading results. The results of the discriminant validity test can be assessed from the logarithmic output in the form of a latent variable correlation. The following shows the data obtained from the results of the convergent and discriminant validity tests.

Table 4. Average Variance Extracted (AVE) Result

Model	Latent Variable	Average Variance Extracted (AVE)	
<b>Model I</b>	OT	0.727	
	KESM	0.770	
	KSU	0.764	
	KEC	OT	0.707
	KofC		0.837
	KAE		0.802
	KIST		0.770
<b>Model II</b>	OT	0.920	
	KESM	0.771	
	KSU	0.777	
	KEC	KESM	0.698
	KofC		0.834
	KAE		0.811
	KIST		0.770
<b>Model III</b>	OT	0.664	
	KESM	0.763	
	KSU	0.784	
	KEC	KSU	0.710
	KofC		0.869
	KAE		0.809
	KIST		0.767
<b>Model IV</b>	OT	0.704	
	KESM	-	
	KSU	0.764	
	KEC	KEC	0.712
	KofC		0.870
	KAE		0.807
	KIST		0.769
<b>Model V</b>	OT	0.724	
	KESM	0.729	
	KSU	0.784	
	KEC	KofC	0.706
	KofC		0.870
	KAE		0.812
	KIST		-
<b>Model VI</b>	OT	0.728	
	KESM	0.765	
	KSU	-	
	KEC	KAE	0.704
	KofC		0.843
	KAE		0.809
	KIST		0.738
<b>Model VII</b>	OT	0.920	
	KESM	0.771	
	KSU	0.747	
	KEC	KIST	0.821
	KofC		0.822
	KAE		0.807
	KIST		0.770

-) the results of the convergent validity is not reliable

The results of AVE in Table 4 shows that almost all PCK components are valid. This component has an AVE value of more than 0.5 (Hair et al., 2017). Based on the analysis, there are only three construct relationships KESM with KEC; KIST with KofC; KSU with KAE that have the AVE values less than 0.5, thus the construct is invalid. It affects the absence of a hypothesis test on the three constructs. The convergent validity test can be seen from the results of outer loading as follows.

Table 5. Outer Loading Result

		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
		OT	KESM	KSU	KEC	KofC	KAE	KIST
OT1		0.916	0.952	0.775	0.874	0.928	0.927	0.952
OT2	OT	0.908	0.966	0.754	0.816	0.879	0.908	0.966
OT3		0.719	-	0.907	0.827	0.733	0.707	-
KESM 1		0.901	0.875	0.812	-	0.977	0.819	0.870
KESM 2	KESM	0.854	0.881	0.931	-	0.710	0.926	0.887
KSU1		0.861	-	0.924	0.865	0.928	-	0.826
KSU2	KSU	0.859	0.920	0.775	0.861	0.769	-	0.889
KSU3		0.900	0.841	0.947	0.895	0.949	-	0.875
KEC1		0.876	0.798	0.887	0.875	0.911	0.824	0.856
KEC2	KEC	0.909	0.942	0.846	0.890	0.841	0.931	0.954
KEC3		0.727	0.755	0.794	0.760	0.761	0.754	-
KofC1		0.836	0.830	0.944	0.929	0.928	0.847	0.811
KofC2	KofC	0.988	0.989	0.921	0.937	0.937	0.984	0.994
KAE1		0.839	0.881	0.870	0.857	0.898	0.868	0.859
KAE2	KAE	0.949	0.920	0.929	0.938	0.904	0.930	0.936
KIST1		0.876	0.876	0.913	0.897	-	0.733	0.869
KIST2	KIST	0.880	0.879	0.837	0.857	-	0.968	0.886

Table 5 shows the results of outer loading which are part of the convergent validity test. There are similarities with the results of the AVE, in which there are two component relationships (KESM, KSU and KIST) with an outer loading value of less than 0.7 which means invalid. The results of the outer loading of construct relationship between KSU1 and KESM; OT3 and KESM also have a value of less than 0.7, but KSU2, KSU2, OT1 and OT3 have a value of more than 0.7, thus it is valid (Hair et al., 2017). The outer loading of construct relationship between OT3 and KIST; KEC3 and KIST also have a value of less than 0.7, but OT1, OT3, KEC1, KEC2 have a value of more than 0.7, thus it is valid. The next validity test is the discriminant validity test which can be seen from the results of the AVE square root and the correlation of the latent variables as follows.

Table 6. The correlation of the latent variables between OT and other components (i.e. KESM, KSU, KEC, KofC, KAE, and KIST).

Construct	AVE square root	OT	KESM	KSU	KEC	KofC	KAE	KIST
OT	0.853	1						
KESM	0.877	0.614	1					
KSU	0.874	0.381	0.469	1				
KEC	0.841	0.442	0.167	0.469	1			
KofC	0.915	0.254	0.376	0.390	0.477	1		
KAE	0.896	0.343	0.170	0.170	0.611	0.255	1	
KIST	0.877	0.839	0.834	0.195	0.186	0.281	0.221	1

Table 6 shows that the AVE square root is greater than the correlation of the latent variables between OT and other components (i.e. KESM, KSU, KEC, KofC, KAE, and KIST), while the correlation of latent variables is smaller than the AVE square root of each component. It means that all PCK components for analyzing the relationship between OT and other components (i.e. KESM, KSU, KEC, KofC, KAE, and KIST) are valid.

Table 7. The correlation of the latent variables between KESM and other components (i.e. OT, KSU, KEC, KofC, KAE, KIST)

Construct	AVE square root	OT	KESM	KSU	KEC	KofC	KAE	KIST
OT	0.959	1						
KESM	0.878	0.637	1					
KSU	0.881	0.295	0.188	1				
KEC	0.835	0.330	0.168	0.476	1			
KofC	0.913	0.238	0.368	0.395	0.434	1		
KAE	0.901	0.312	0.172	0.215	0.637	0.255	1	
KIST	0.877	0.836	0.837	0.225	0.194	0.285	0.215	1



Table 7 shows that the AVE square root is greater than the correlation of the latent variables between KESM (i.e OT, KSU, KEC, KofC, KAE, KIST), while the correlation of latent variables is smaller than the AVE square root of each component. It means that all PCK components for analyzing the relationship between between KESM (i.e OT, KSU, KEC, KofC, KAE, KIST) are valid. The PCK components tested in the latent variable correlation are following the results of the convergent validity test, so this study used OT, KSU, KofC, and KIST only out of the seven components as well as their relationship with KESM.

Table 8. The correlation of the latent variables between KSU and other component (i.e OT, KESM KEC, KofC, KAE, KIST)

Construct	AVE square root	OT	KESM	KSU	KEC	KofC	KAE	KIST
OT	0.815	1						
KESM	0.873	0.498	1					
KSU	0.885	0.457	0.110	1				
KEC	0.843	0.486	0.100	0.446	1			
KofC	0.932	0.188	0.230	0.414	0.503	1		
KAE	0.899	0.316	0.179	0.115	0.544	0.195	1	
KIST	0.876	0.756	0.827	0.172	0.165	0.246	0.201	1

Table 8 shows that the AVE square root is greater than the correlation of the latent variables between KSU and other component (i.e OT, KESM KEC, KofC, KAE, KIST), while the correlation of latent variables is smaller than the AVE square root of each component. It means that all PCK components for analyzing the relationship between KSU and other component (i.e OT, KESM KEC, KofC, KAE, KIST) are valid.

Table 9. The correlation of the latent variables between KEC and other components (i.e OT, KESM, KSU, KofC, KAE, KIST).

Construct	AVE square root	OT	KSU	KEC	KofC	KAE	KIST
OT	0.839	1					
KSU	0.874	0.429	1				
KEC	0.844	0.502	0.472	1			
KofC	0.933	0.216	0.410	0.486	1		
KAE	0.898	0.337	0.164	0.588	0.206	1	
KIST	0.877	0.787	0.190	0.179	0.241	0.210	1

Table 9 shows that the AVE square root is greater than the correlation of the latent variables between KEC and other components (i.e OT, KESM, KSU, KofC, KAE, KIST), while the correlation of latent variables is smaller than the AVE square root of each component. It means that all PCK components for analyzing the relationship between KEC and other components (i.e OT, KESM, KSU, KofC, KAE, KIST) are valid.

Table 10. The correlation of the latent variables between KofC and other components (i.e OT, KESM, KSU, KEC, KAE, KIST).

Construct	AVE square root	OT	KESM	KSU	KEC	KofC	KAE
OT	0.851	1					
KESM	0.854	0.601	1				
KSU	0.885	0.343	0.085	1			
KEC	0.840	0.456	0.205	0.447	1		
KofC	0.933	0.214	0.354	0.410	0.516	1	
KAE	0.901	0.326	0.140	0.109	0.523	0.206	1

Table 10 shows that the AVE square root is greater than the correlation of the latent variables between KofC and other components (i.e OT, KESM, KSU, KEC, KAE, KIST), while the correlation of latent variables is smaller than the AVE square root of each component. It means that all PCK components for analyzing the relationship between KofC and other components (i.e OT, KESM, KSU, KEC, KAE, KIST) are valid.

Table 11. The correlation of the latent variables between KAE and other components (i.e OT, KESM, KSU, KEC, KofC, KIST).

Construct	AVE square root	OT	KESM	KEC	KofC	KAE	KIST
OT	0.853	1					
KESM	0.875	0.593	1				
KEC	0.839	0.442	0.133	1			
KofC	0.918	0.251	0.329	0.450	1		
KAE	0.899	0.335	0.178	0.628	0.249	1	
KIST	0.859	0.813	0.827	0.183	0.135	0.255	1

Table 11 shows that the AVE square root is greater than the correlation of the latent variables between KAE and other components (i.e OT, KESM, KSU, KEC, KofC, KIST), while the correlation of latent variables is smaller than the AVE square root of each component. It means that all PCK components for analyzing the relationship between KAE and other components (i.e OT, KESM, KSU, KEC, KofC, KIST) are valid.

Table 12. The correlation of the latent variables between KIST and other components (i.e OT, KESM, KSU, KEC, KofC, KAE)

Construct	AVE square root	OT	KESM	KSU	KEC	KofC	KAE	KIST
OT	0.959	1						
KESM	0.878	0.636	1					
KSU	0.864	0.267	0.160	1				
KEC	0.906	0.364	0.163	0.456	1			
KofC	0.907	0.246	0.377	0.386	0.442	1		
KAE	0.898	0.319	0.173	0.190	0.647	0.264	1	
KIST	0.877	0.837	0.838	0.207	0.208	0.287	0.221	1

Table 12 shows that the AVE square root is greater than the correlation of the latent variables between KIST and other components (i.e OT, KESM, KSU, KEC, KofC, KAE), while the correlation of latent variables is smaller than the AVE square root of each component. It means that all PCK components for analyzing the relationship between KIST and other components (i.e OT, KESM, KSU, KEC, KofC, KAE) are valid. Tables 6 to 12 show that the PCK components in this study have met the discriminant validity requirements.

The second stage before testing the hypothesis is the reliability test of the PCK components. The reliability test of the PCK components (variables) aims to determine whether the variables in this study are reliable or not, which will be related to the number of variables for hypothesis testing (Awang et al., 2015). The results of the PCK component reliability test are presented in the following table.

Table 13. Variable Reliable Test Result

		OT	KESM	KSU	KEC	KofC	KAE	KIST
OT	Cronbach's Alpha	0.806	0.914	0.806	0.806	0.806	0.806	0.914
	Composite Reliability	0.888	0.958	0.855	0.877	0.886	0.888	0.958
KESM	Cronbach's Alpha	0.704	0.704	0.704	-	0.704	0.704	0.704
	Composite Reliability	0.870	0.871	0.865	-	0.840	0.866	0.871
KSU	Cronbach's Alpha	0.857	0.719	0.857	0.857	0.857	-	0.857
	Composite Reliability	0.906	0.874	0.915	0.906	0.915	-	0.898
KEC	Cronbach's Alpha	0.798	0.798	0.798	0.798	0.798	0.798	0.795
	Composite Reliability	0.878	0.873	0.880	0.881	0.877	0.876	0.901
KofC	Cronbach's Alpha	0.851	0.851	0.851	0.851	0.851	0.851	0.851
	Composite Reliability	0.911	0.909	0.930	0.930	0.930	0.915	0.902
KAE	Cronbach's Alpha	0.769	0.769	0.769	0.769	0.769	0.769	0.769
	Composite Reliability	0.890	0.896	0.895	0.893	0.896	0.894	0.893
KIST	Cronbach's Alpha	0.701	0.701	0.701	0.701	-	0.701	0.701
	Composite Reliability	0.870	0.870	0.868	0.869	-	0.847	0.870

Reliability test results are reliable if the value of Cronbach’s Alpha is more than 0.6 and the composite reliability is more than 0.7 (Hair et al., 2017). Table 13 shows that the Cronbach’s Alpha of all PCK components (variables) is more than 0.6, as well as the composite reliability value of all PCK components that is more than 0.7. Therefore, in conclusion, the PCK components in this study are reliable.

### Findings / Results

PLS-SEM test is the research hypothesis test obtained by running a bootstrapping program. The hypothesis is accepted or the PCK component (variable) has a positive relationship if it has a t-statistic value of more than 1.64 (Hair et al., 2017). The following are the test results of the seven hypotheses presented in the path coefficient value and structural model.

Table14. Path Coefficient Results

Construct	T Statistic (IO/STERII)						
	Hypotheses1 OT	Hypotheses 2 KESM	Hypotheses 3 KSU	Hypotheses 4 KEC	Hypotheses 5 KofC	Hypotheses 6 KAE	Hypotheses 7 KIST
OT	1						
KESM	<b>0.895</b>	1					
KSU	<b>0.994</b>	<b>0.217</b>	1				
KEC	2.094	<b>0.019</b>	<b>0.104</b>	1			
KofC	<b>1.039</b>	<b>0.957</b>	<b>1.417</b>	<b>2.005</b>	1		
KAE	<b>0.079</b>	<b>0.043</b>	<b>0.559</b>	<b>2.955</b>	<b>0.069</b>	1	
KIST	3.793	3.774	<b>1.108</b>	<b>2.161</b>	-	<b>0.780</b>	1

\*) (-) Not included in hypothesis testing

\*\*) The bold number means less than 1.64 or the PCK component has a negative (weak) relationship.

Table 14 shows that only 13 PCK components that have a positive (strong) relationship with other PCK components overall. However, this result does not mean that only a few components affect other components, but it rather has a negative (weak) relationship. Besides, Table 14 shows that the relationship between OT and KIST is the strongest one among PCK components (i.e.4.571). The weakest component relationship is that of between KAE and KESM (i.e. 0.043). Meanwhile, the component that has a negative or weak relationship with all components is KSU. The results of the hypothesis test are clearly described in a structural model as follows.

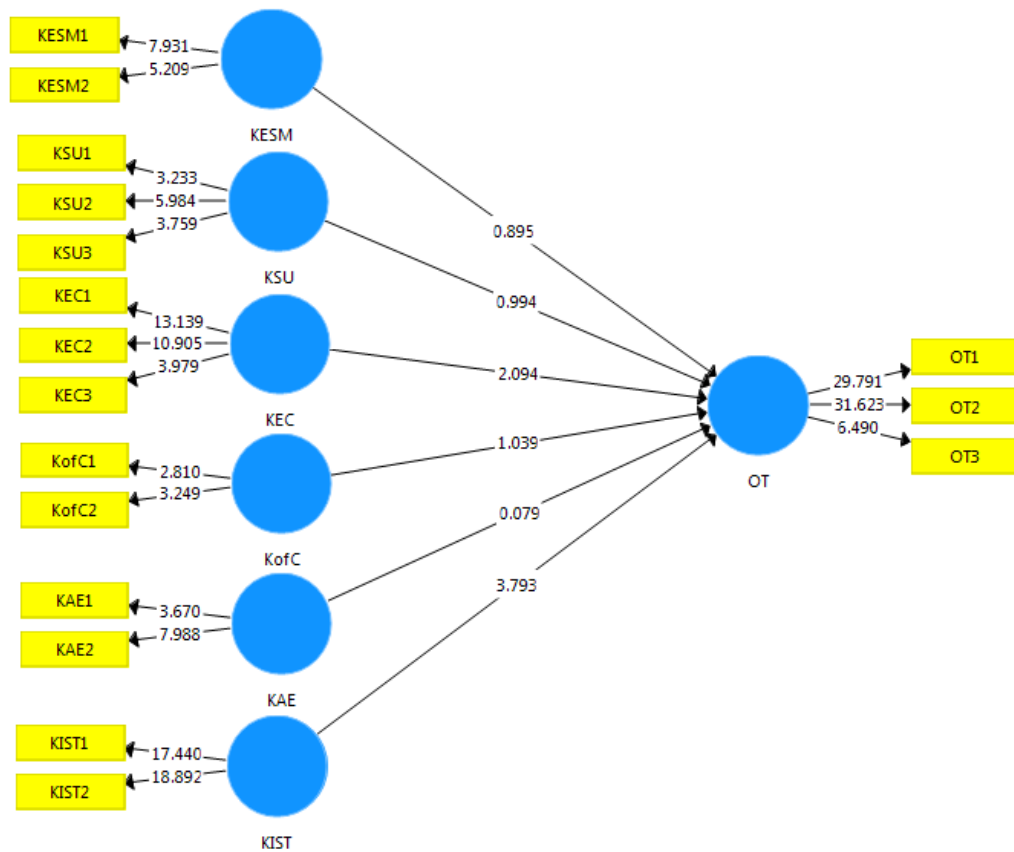


Figure 2. The relationship between OT and other components (i.e. KESM, KSU, KEC, KofC, KAE, and KIST).

Figure 2 shows that there is a positive relationship in hypothesis 1 between KEC and OT (i.e. 2.094); KIST and OT (i.e.3.794). The value of  $Q^2$  is 0.552 (hypothesis 1), it is means that the model has predictive relevance. The strongest component relationship (hypothesis 1) is that of between KIST and OT (i.e. 3.794). Meanwhile, KESM, KSU, KofC, and KAE have a negative (weak) relationship with OT. It means that there are two PCK components in hypothesis 1 (KSU, KofC, and KIST) which have a positive relationship with OT or the hypothesis is accepted. Meanwhile, four PCK components (KESM, KSU, KofC, and KAE) have a negative relationship with OT or the hypothesis is rejected.

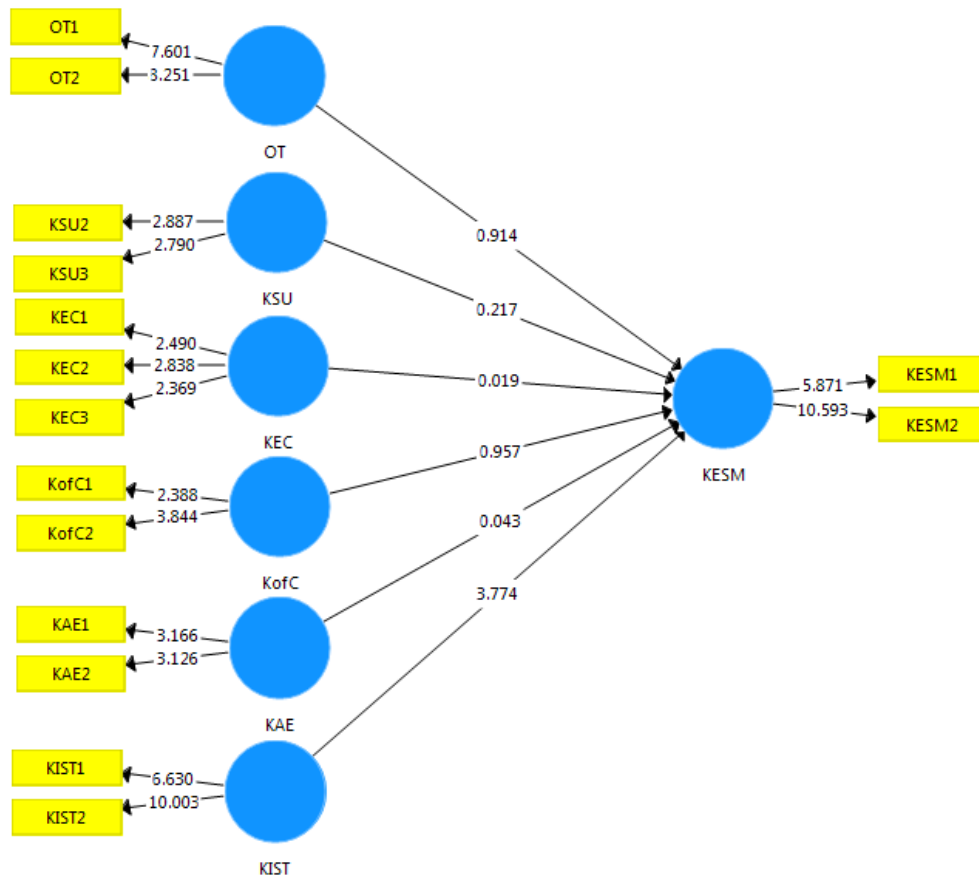


Figure 3. The relationship between KESM and other components (i.e.OT, KSU, KofC, and KIST).

The test of hypothesis 2 was used to find out the relationship between OT, KSU, KEC, KofC, KAE, KIST, and KESM with value of  $Q^2$  is 0.468. That is means that the model has predictive relevance. Hypothesis test results (figure 3) show that it is only KIST that has a positive relationship with KESM (i.e. 3.774). It means that there is one PCK components in hypothesis 2 (KIST) which have a positive relationship with KESM or the hypothesis is accepted. Meanwhile, five PCK components (OT, KSU, KEC, KofC, and KAE) have a negative relationship with KESM or the hypothesis is rejected.

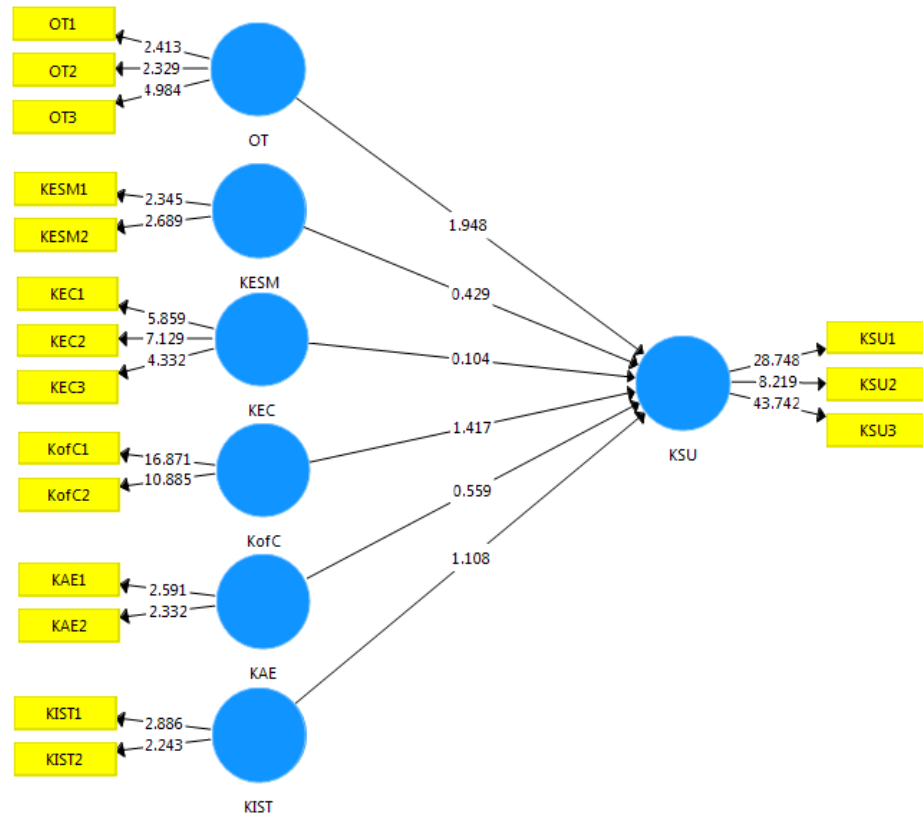


Figure 4. The relationship between KSU and other components (i.e.OT, KESM, KEC, KofC, KAE and KIST).

Figure 4 shows the results of the hypothesis 3 test, which is the relationship between KSU and other components (OT, KESM, KEC, KofC, KAE, and KIST) . Hypothesis test results show that it is only OT that has a positive relationship with KSU (i.e. 1.948) with value of  $Q^2$  is 0.268, and it means that the hypothesis is accepted and the model has predictive relevance. Meanwhile, the other components (KESM, KEC, KofC, KAE, and KIST) have a negative (weak) relationship with KSU or the hypothesis is rejected.

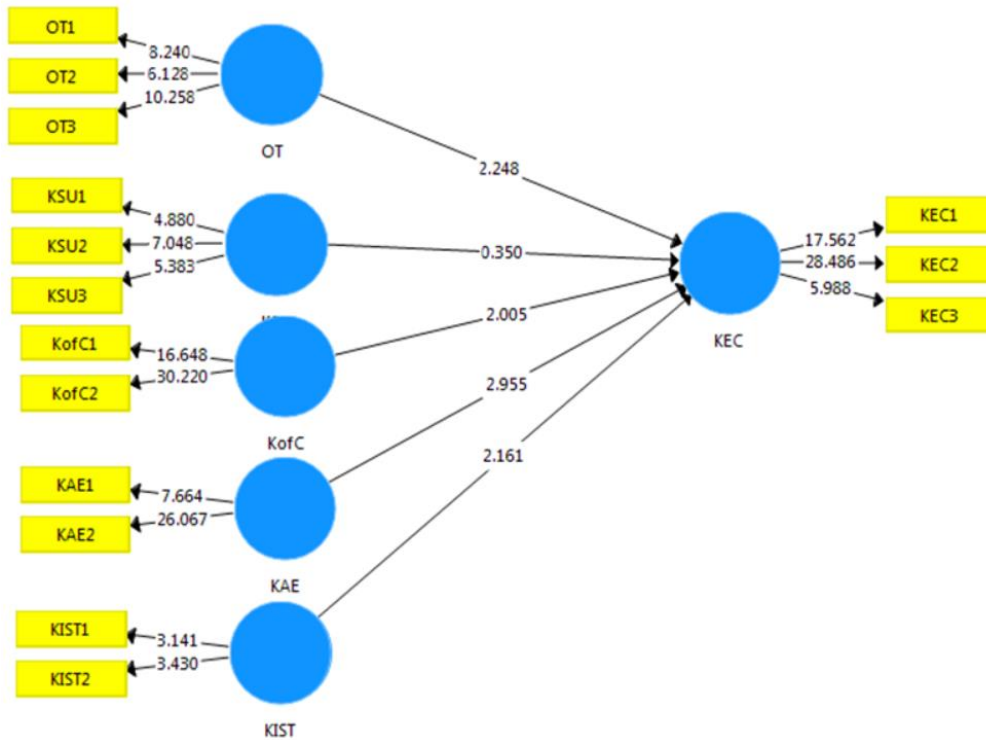


Figure 5. The relationship between KEC and other components (i.e.OT, KESM, KSU, KofC, KAE and KIST).

Figure 5 shows hypothesis 4, which is the relationship between KEC and other components (i.e. OT, KESM, KEC, KSU, KofC, KAE, and KIST). Hypothesis 4 has the most positive relationship between components among other hypotheses. The value of  $Q^2$  is 0.428 (hypothesis 4), it means that the model has predictive relevance. Hypothesis test results show that it is only KSU that has a negative (weak) relationship with KEC (i.e.0.350) or the hypothesis is rejected. Meanwhile, the other components (OT, KofC, KAE, and KIST) have a positive relationship with KEC and it means that the hypothesis is accepted.

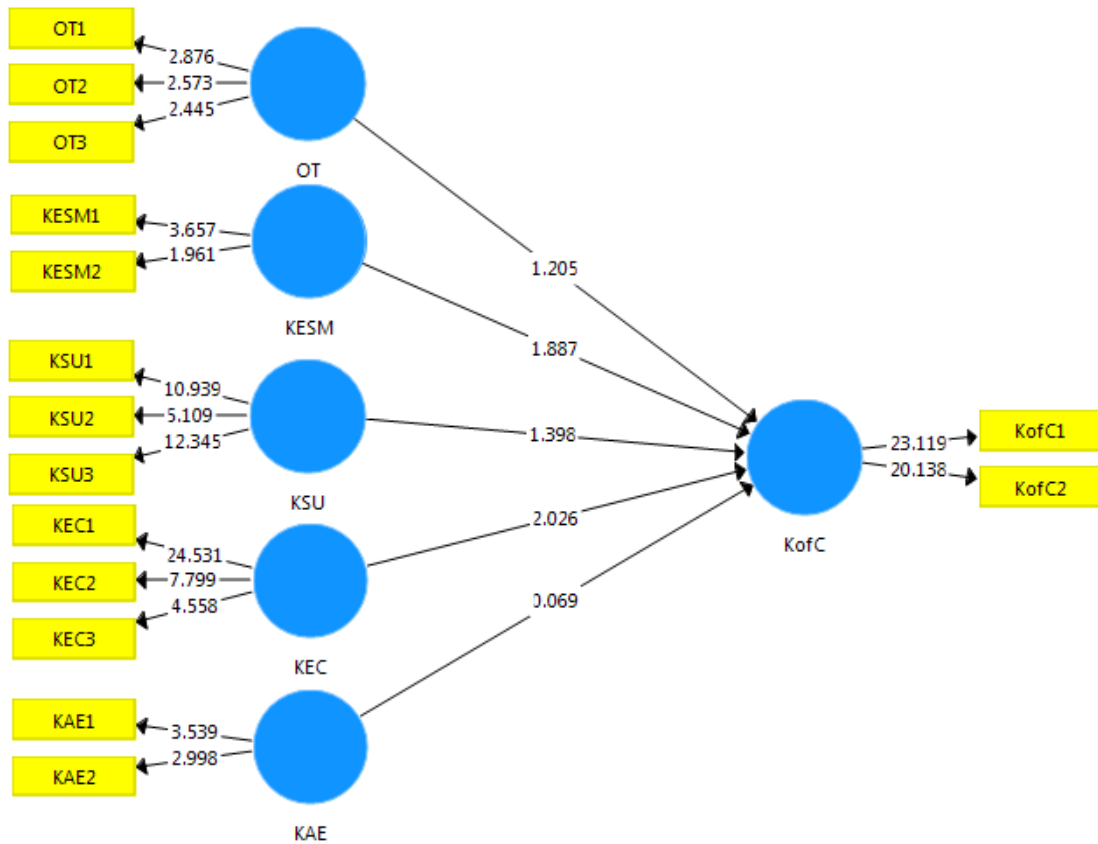


Figure 6. The relationship between KofC and other components (i.e.OT, KESM, KSU, KEC, KAE and KIST).

The results of the hypothesis 5 test, which is the relationship between KofC and other components (i.e. OT, KESM, KSU, KEC, KAE, and KIST) are presented in Figure 6. The value of  $Q^2$  is 0.268 (hypothesis 5), it means that the model has predictive relevance. Of the tested six components, there are two PCK components (KESM and KEC) that have a positive relationship with KofC, or the hypothesis is accepted. The strongest relationship of the positive components in hypothesis 5 is that of between KEC and KofC (i.e. 2.026), while the weakest one is that of between KAE and KofC (i.e. 0.069). The relationship between KSU and KofC is one of the three components that has a negative relationship with KofC (OT, KSU, KAE) or the hypothesis is rejected.

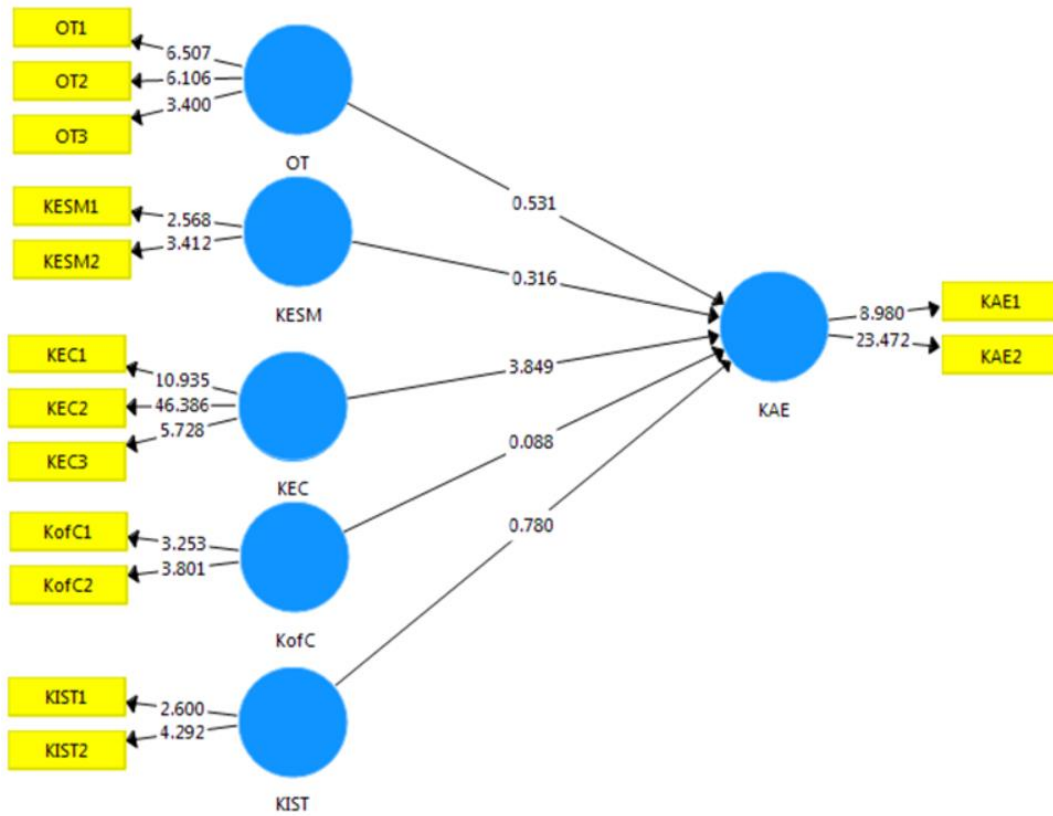


Figure 7. The relationship between KAE and other components (i.e.OT, KESM, KSU, KEC, KofC and KIST).

Figure 7 shows the results of the hypothesis 6 test (the relationship between KAE and other components, i.e. OT, KESM, KSU, KofC, KEC, and KIST) with value of  $Q^2$  is 0.170. The results indicate that there is only one KEC that has a positive relationship with KAE (i.e.3.849) and it means that the hypothesis is accepted. Meanwhile, the other components (OT, KESM, KSU, KofC, and KIST) have a negative (weak) relationship with KAE or the hypothesis is rejected.

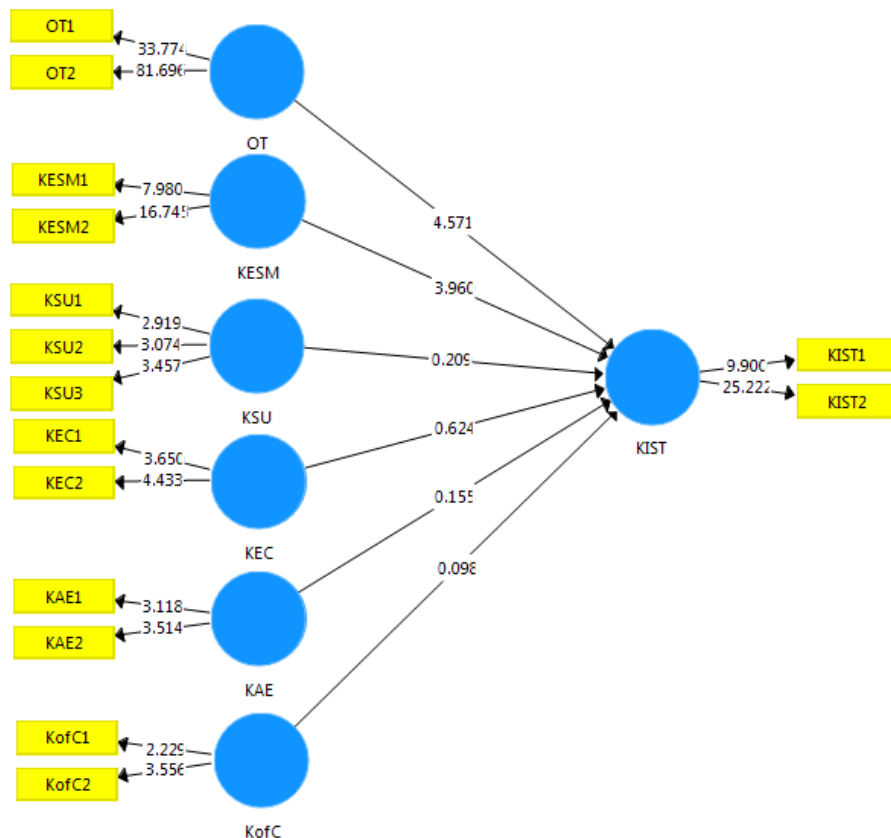


Figure 8. The relationship between KIST and other components (i.e.OT, KESM, KSU, KEC, KofC and KAE).

The results of the hypothesis 7 test (the relationship between KofC and other components, i.e. OT, KESM, KSU, KEC, KAE, and KIST) are presented in Figure 6. The value of Q2 is 0.557 (hypothesis 7), it means that the model has predictive relevance. Of the tested six components, there are two components (OT and KESM) that have a positive relationship with KIST, or the hypothesis is accepted. The strongest relationship of the positive components in hypothesis 7 is that of between OT and KIST (i.e. 4.571). The relationship between OT and KIST is the strongest positive relationship of all PCK component relationships at the same time. The other four components (KEC, KofC, KAE, and KIST) have a negative relationship with KIST or the hypothesis is rejected.

#### *Qualitative Analysis of Kindergarten Teacher on Pedagogical Content Knowledge*

The qualitative analysis in this research used the Co-Re instrument and data sources obtained from interviews conducted on the kindergarten teachers.

*Table 8. The Qualitative Analysis Results of PCK Component Data of Kindergarten Teachers*

<b>Question</b>	<b>Number of Corresponding Answers</b>	<b>Representative Statement</b>	<b>PCK Component Relationship</b>
What is the purpose of teaching themes in the fields of developing religious and moral values (NAM), social-emotional (SE), language (B), cognitive (K), physical motor (FM), and art (S) to early childhood (AUD) ?	30	NAM: introduce God's creation, SE: has an attitude of loving animals, "an example is the students feeding animals!" B: children tend to develop language skills by imitating animal sounds. K: introducing the students to the concept of numbers through various animal images, "they match the symbol of numbers with pictures of animals. FM: stimulates the children's physical motor when they imitate the animal's movements. SN: introducing/teaching the children how to make animal cages using matchsticks. (Bibi)	OT, KESM, KSU, KEC, KofC, KIST
Why is it important to develop all aspects of early childhood through this theme?	27	Because teachers believe that children's ability tend to develop optimally by using themes that are easy and close to everyday life, and in accordance with the curriculum for early childhood learning (Nency)	OT, KSU, KEC, KofC
What do you know about this theme (or is the plan for it to be accepted by early childhood, not intensive)?	25	Bringing animals to school in order to observe their characteristics and mention the names of these animals. (Sutriani)	OT, KESM, KIST
What are the difficulties/limitations associated with teaching early childhood with this theme?	30	The difficulties and limitations encountered are when you have to teach children with real objects. In this theme, there is a need to present real animals. Sometimes, there is a need to suppress disgust and fear of certain animals, in order for the children to get to know animals well. (Ima)	OT, KSU, KIST
How does the knowledge of early childhood (cognitive) thinking influence your teaching plan on this theme?	20	When children encounter difficulties during a learning process, at that time, the teacher needs to think of appropriate methods to understand what is taught and are able to imitate the process. For example, children find it difficult to sort the stages of frog development. Therefore they are taught by repeating frog songs, and stories are even told spontaneously. (Ari)	OT, KESM, KSU, KEC, KofC, KAE, KIST
What are the teaching procedures employed and specific reasons for applying it to this theme?	30	Children are introduced to animals through pictures. The teacher explains each picture until the student understands it. The learning procedures are generally following the curriculum of early childhood, which consists of opening (apperception), core, closing (reflection and recalling) (Firo)	OT, KSU, KEC, KIST
Are there specific methods to assess the understanding or difficulties encountered by early childhood regarding this theme in each field of development? Explain! (including the child's response to the assessment carried out)	30	Special assessments are made when students bring real animals, their knowledge and understanding of this theme are also explored. Other assessment processes are carried out in accordance with the curriculum of early childhood. The child's response is a happy mood because the student does not realize that the teacher conducted an assessment (they focus on the real animal). (Emi)	KofC, KEC, KAE



The second analysis was conducted qualitatively through interviews and observations of kindergarten teachers in response to the purpose of this research. The results from the qualitative analysis of the relationship between the PCK components support the outcome of the quantitative investigation. This is in accordance with using animal themes to show that teachers also need to be able to stimulate all aspects of development, not just cognitive abilities. The PCK component that was very visible from Bibi's answer was Orientation of Teaching (OT). Bibi has an orientation that through teaching with animal themes, Bibi must be able to stimulate all aspects of child development. In Auntie's answer, the OT component also seems to be related to the five other components, namely knowledge of ECE subject matter (KESM), knowledge of student's understanding in learning (KSU), knowledge of early childhood education curriculum (KEC), knowledge of context (KofC), knowledge of instructional strategies (KIST).

In addition to the orientation of teaching (OT) component, kindergarten teachers must also have knowledge of the curriculum (KEC). This can be confirmed in Nancy's statement in answering the importance of developing all areas of early childhood development through animal themes. Nancy's statement concerning the importance of developing all aspects of early childhood abilities using animal themes, stated that *"the teacher is expected to optimally develop the child's ability with themes that are easy and close to everyday life as well as following the learning curriculum of early childhood."* Although knowledge of early childhood education curriculum (KEC) is very much needed in learning for kindergarten students, it shows that childhood education curriculum (KEC) is not the most frequent component in the results of qualitative data analysis.

Generally, the PCK components that often emerge in the statements of kindergarten teachers and from the results are orientation of teaching (OT). The kindergarten teachers properly show four PCK components, such as knowledge of context (KofC), knowledge of instructional strategies (KIST), knowledge of student's understanding in learning (KSU), and knowledge of assessment of early childhood education (KAE). On the other hand, the results of the qualitative analysis show that kindergarten teachers are still weak in the assessment knowledge of early childhood development and knowledge of the materials. It is indicated by the assessment of early childhood education (KAE) and knowledge of ECE subject matter (KESM) components found in some statements in the Co-Re instrument and the results of observation only. The results of observations that show the weakness of knowledge of ECE subject matter (KESM) kindergarten teachers in the theme of animals, one of which can be seen in the statement of one teacher *"based on their habitat, animals are divided into 3 types, namely aquatic, air, and land animals"*. Even though the animal habitat is only on land and water.

### Discussion

According to the analysis, the orientation of teaching (OT) appeared frequently and tended to influence other components. The results from the data analysis that orientation of teaching (OT) is a PCK component that has the strongest positive relationship of all components, but it enables the relationship between orientation of teaching (OT) and knowledge of instructional strategies for teaching (KIST) only. This can be seen in the hypothesis 7 test that there is a positive relationship between orientation of teaching (OT) and knowledge of instructional strategies (KIST) (i.e. 4.571).

The PCK component that often has positive relationships with other components is orientation of teaching (OT), knowledge of early childhood education (ECE) curriculum (KEC), and knowledge of instructional strategies (KIST). Orientation of teaching (OT), consisting of the relationship between knowledge of student's understanding in learning (KSU), knowledge of early childhood education (ECE) curriculum (KEC), and and knowledge of instructional strategies (KIST). Knowledge of early childhood education (ECE) curriculum (KEC), consisting of the relationship between orientation of teaching (OT), knowledge of context (KofC), and knowledge of instructional strategies (KIST). Knowledge of instructional strategies (KIST), consisting of the relationship between orientation of teaching (OT), knowledge of Early Childhood Education (ECE) subject matter (KESM), and knowledge of early childhood education (ECE) curriculum (KEC). The results of the data analysis are not in line with the research (Suh & Park, 2017) which reveals that the knowledge of curriculum is the PCK component that is rarely connected to other components or has limited connection. However, their statement is in line with the results of the quantitative and qualitative analysis in this study which shows that orientation of teaching (OT) is the component that is most often connected to other PCK components.

The difference in the results of the analysis supports the opinion of the previous studies that the results of PCK research are still developing and make PCK a complex and interesting teaching variable to be analyzed based on the field of study or the related learning themes (Wu et al., 2019). The results of this study also indicate that it is very important for kindergarten teachers to have orientation of teaching (OT), knowledge of curriculum (KEC), and knowledge of instructional strategies (KIST) components in the learning processes. This are in line with (Zhang, 2015) that one way to be successful in learning is that teachers must have knowledge of the curriculum. Teacher knowledge on the curriculum (KEC) supports the abilities of teachers to provide a learning environment according to the context or stage of children's development, and all of these are factors affecting early childhood learning (Inan, 2010). The result of another study that supports the importance of knowledge about learning strategies is revealed by Cobanoglu & Sevim (2019) that children must feel comfortable with learning in a school environment.

Based on the Co-Re instrument obtained through interviews, observations, and qualitatively analysis, it confirms that the knowledge of instructional strategies (KIST) component is one component of kindergarten teachers, but it is not the one mostly found in this study. Even so, the opinion of Sutriani and Ima, represents the knowledge of instructional strategies (KIST) component that by the teacher. Sutriani and Ima stated that the teacher chose a learning strategy to brought animals to school in real time, so the school was also a fun place for learning through concrete things. This was consistent with the opinion (Dejonckheere et al., 2016) that teachers must design an environment where learning activities so that children are able to explore yesterday.

The PCK component for kindergarten teachers that has the weakest relationship with other components is knowledge of student's understanding in learning (KSU), knowledge of assessment of early childhood education (KAE), knowledge of context (KofC) and knowledge of early childhood education subject matter (KESM). These results support the research on the relationship between PCK components in Biology lessons in high school (Park & Chen, 2012), resulting in research findings that knowledge of assessment have the most limited relationship with other components. The results of PCK research on kindergarten teachers and Biology teachers show differences, that is, the knowledge of curriculum component in kindergarten teachers is not a component that has a limited relationship with other components. The difference in the results of this study supports Kabita and Grace, (2016) and Zhang (2015) in their research, which stated that the pedagogical task of early childhood teachers requires a different knowledge base from that of educators in primary and secondary education.

### Conclusion

This research has several analysis in the development of the PCK components of kindergarten teachers as follows: a) the relationship between the components is specified in the context of using themes to learn in the kindergarten b) analysis of the relationships between the components is carried out separately, such as the relationship of all 7 (seven) components to 1 (one) PCK component of kindergarten teachers, c) Orientation of teaching (OT) has the strongest relationship with knowledge of instructional strategies (KIST); d) knowledge of assessment of early childhood education (KAE) has the weakest relationship with knowledge of early childhood education subject matter (KESM); e) PCK components for kindergarten teachers that are often found and associated with other components in a learning episode are orientation of teaching (OT), knowledge of early childhood education (ECE) curriculum (KEC), and knowledge of instructional strategies (KIST); f) knowledge of student's understanding in learning (KSU), knowledge of assessment of early childhood education (KAE), knowledge of context (KofC) and knowledge of ECE subject matter (KESM) are the components that have the most limited relationship with other components.

Each of the components contributes to its development in kindergarten teachers. However, those that need to be possessed by kindergarten teachers in order to be able to teach themes in accordance with children's development are orientation of teaching (OT), knowledge of early childhood education (ECE) curriculum (KEC), and knowledge of instructional strategies (KIST). Others, such as knowledge of student's understanding in learning (KSU), knowledge of assessment of early childhood education (KAE), knowledge of context (KofC) and knowledge of early childhood education subject matter (KESM) , also need to be optimized to support the formation of kindergarten teachers' PCK. For prospective educators and kindergarten teachers, the results from this research tend to provide an overview of the PCK components that need to be maximized during the lecture process and also strengthened during internship programs. However, PCK experience possessed by prospective educators and kindergarten teachers is directly proportional to that of teaching in early childhood. It also provides information that is related to PCK components that need to be developed through learning, particularly animal themes.

### Suggestion

Interesting information obtained from this research serves as the basis for the analysis of other factors that influences the relationship of each PCK component possessed by the teachers, such as their educational background, experience, gender, and beliefs. Also, the study on the relationship between PCK components and the innate factors possessed by teachers will certainly contribute to the development of more complex PCK research for kindergarten teachers. Future research should still use the mix method research, but it will be more in-depth and complete this research, if you use sequential exploratory research type. In addition, it would be very interesting if the relationship of latent variables with other components can be analyzed in depth by making one of the PCK components as a mediating variable.

### Limitations

There are several PCK components frequently found in this study and are very important for kindergarten or pre-service teachers to have. The less optimal PCK components, such as knowledge of student's understanding in learning (KSU), knowledge of assessment of early childhood education (KAE), knowledge of context (KofC) and knowledge of early childhood education subject matter (KESM), will likely interact more with other components if the researchers can link the analysis of the interaction of PCK components with teachers' educational background, gender, teachers' self-efficacy, one of the PCK components as a mediating variable, or other factors that can affect the PCK development of kindergarten teachers. Other factors influencing the relationship between PCK components, such as teacher self-

efficacy, gender, and teacher education experience were not investigated deeply in this research. Park and Oliver (2008) for example, identified the relationship of the PCK component to teacher self efficacy; Lee (2017) identified the relationship of the PCK dimension with gender and teacher teaching experience.

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