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# Validation of the Assessment of Teachers' Pedagogical Content Knowledge as a Self-Assessment with K-12 Teachers in a Title 1 School District

Jami Michel Moore

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This dissertation has been read and approved as fulfilling the partial requirement for the Degree of Doctor of Education in Curriculum and Leadership.

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# VALIDATION OF THE ASSESSMENT OF TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE AS A SELF-ASSESSMENT WITH K-12 TEACHERS IN A TITLE 1 SCHOOL DISTRICT

by

Jami Michel Moore

A Dissertation
Submitted in Partial Fulfillment of
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DEDICATION

This dissertation is dedicated to my amazing family, Scott Moore, my husband, and our daughters, Alysa, Ashley, and Sarah. Thank you for your continued support and encouragement. I love you all beyond measure.

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To my wonderful family and friends, your unwavering support and encouragement through this process are greatly appreciated; I could not have accomplished this goal without you. I praise God for providing the drive and determination to stay the course and complete this journey.

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My husband, Scott, and our daughters, Alysa, Ashley, and Sarah, without their steadfast love, support, and encouragement, despite the many sacrifices, I would not have completed this journey.

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Abstract

Teacher quality has become a topic of national discussion due to the United States' lagging behind other countries' success on both international and national assessments. Validation of the Assessment of Teachers' Pedagogical Content Knowledge (ATPCK) as a self-assessment with K-12 teachers in a Title 1 school district is the purpose of this research. Assessing teachers' pedagogical content knowledge (PCK) growth as a result of professional development is a challenge. Utilizing confirmatory factor analysis allowed the researcher to determine the validity and reliability of the ATPCK as a self-assessment measure of teachers' PCK. The research results will be utilized to support the improvement of future district and site-based evaluation of teacher professional development practices.

*Keywords:* pedagogical content knowledge (PCK), components of PCK: subject matter knowledge, instructional objective and context, knowledge of students' understanding, and instructional representation and strategies, lesson study, and professional learning communities.

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# CHAPTER 1

# INTRODUCTION

## Background of the Problem

> In President Kennedy's historic 1962 address to Rice University, he stated …our leadership in science and industry, our hopes for peace and security, our obligations to ourselves as well as others, all require us to make this effort to solve these mysteries, to solve them for the good of all men, and to become the world's leading spacefaring nation (Hare, 1999, p. 2).

In the 55 years since these words were spoken, education has seen multiple reforms. Unfortunately, after the many reform attempts, local systems' and teachers' understandings of the reform efforts have resulted in the development of "divergent interpretations" (Coburn, Hill, & Spillane, 2016, p. 3). Still, other reform efforts focused on professional knowledge and pedagogy competencies and identifying the "missing paradigm" (Shulman, 1986, p. 6) in professional knowledge. Shulman (1986) referred to this *missing paradigm* as pedagogical content knowledge (PCK): a teachers' ability to utilize the most informative representation of ideas, analogies, illustrations, examples, explanations, and demonstrations to make content matter comprehensible by students. Mitcheltree (2006) identified PCK to include the teaching mechanisms of lesson planning, classroom management, and assessment. Jang, Guan, and Hsieh (2009) and Lucenario, Yangco, Punzalan, and Espinosa (2016) identified the four domains of PCK as subject matter knowledge (SMK), instructional objective and context (IOC),

knowledge of student understanding (KSU) and instructional representation and strategies (IRS). Improving teachers' PCK has become a dominate discussion in educational research, and continues to be of significance in teachers' professional development (Wu, 2014).

Because teacher PCK had been shown to impact student achievement (Gess-Newsome, 2013) significantly, multiple studies focused on the development of PCK in elementary and secondary pre-service teachers (Aydeniz & Demet, 2014; Barnett, 2015) and secondary in-service teachers have occurred (Evens, Elen, & Depaepe, 2015; Kirschner, Borowski, et al., 2016; Lucenario et al., 2016). However, Smith and Banilower (2015) stated that to effectively evaluate how improved PCK impacts student learning, a quality assessment of PCK must be developed. Park and Suh (2015) shared that valid and reliable PCK measures for "large-scale use" (p. 105) are necessary for understanding the relationship between teachers' PCK development and improved student achievement. Therefore, the researcher evaluated Lucenario et al.'s (2016) Assessment of Teachers' Pedagogical Content Knowledge (ATPCK) as a self-assessment in a K-12 Title 1 school district.

## Statement of the Problem

Teacher quality has become a topic of national discussion due to the United States' lagging behind other countries' success on both international and national assessments such as Partnership for Assessment of Readiness for College and Careers (PARCC) and the National Assessment of Educational Progress (NAEP). One of the relevant components of teacher quality is PCK (Baumert et al., 2010; Park & Suh, 2015; Shulman, 1986; Shulman, 1987). In recognition of the need for improved teacher quality,

educational reform efforts intended to improve teacher quality required professional development, which provided support and guidance to ensure effective teacher learning opportunities (Borko, 2004). Aydeniz and Demet (2014) indicated that developing the PCK of in-service teachers across multiple domains of knowledge, and across diverse classroom environments, had proven to be quite challenging due to the complexity of PCK. Park and Suh (2015) pointed out in their research that PCK complexity was reflected in the lack of a clear definition of PCK as well as a limited understanding of PCK. However, Henze and Van Driel (2015) stated that because PCK developed over time and was flexible and reflective of teachers' experience, targeted professional development can lead to improved teacher PCK. Unfortunately, Smith and Banilower (2015) shared that assessing PCK has been "characterized…by uncertainty" and was "complex" (p. 99). This study intended to address the challenge of assessing teachers' PCK by confirming the construct validity and reliability of the ATPCK as a teacher self-assessment.

## Purpose of the Study

Confirmation of construct validity and reliability of the ATPCK as a self-assessment survey with K-12 teachers in a Title 1 school district was the focus of this research. **S**tudies have shown that professional teacher knowledge identified as PCK was a significant contributor to students' academic achievement (Gess-Newsome, 2013). Unfortunately, according to Loewenberg Ball, Thames, and Phelps (2008), empirical evidence for clear domains of teacher knowledge was lacking, and without this evidence, theoretical ideas of teacher knowledge would have a "limited role in improving teaching and learning" (p. 390). Although, research on measuring teachers' PCK had proven to be

complex and challenging (Smith & Banilower, 2015), Jang et al. (2009), Jang (2011), and Lucenario et al. (2016) effectively utilized the ATPCK as a measure of students' perception of their teachers' PCK. The purpose of this study was to confirm the construct validity and reliability of the ATPCK utilized by Lucenario et al. (2016) as a self-assessment measure with K-12 teachers in a Title 1 school district.

## Conceptual Framework

Professional development effectiveness has become a topic of "heightened interest" (Kelleher, 2003, p. 751) due to the increased awareness of the impact of adult learning on student achievement. Therefore, there was a need for teachers' mastery of instructional competencies (Mardapi, Sugiman, & Herawan, 2018). Aldahmash, Alshamrani, Alshaya, and Alsarrani (2019) stated that professional development practices must utilize teacher competency data along with student achievement data.

In their meta-analysis, Aldahmash et al. (2019) found that PCK became a focus of analytical research because teachers "think" (p. 172) quality PCK results in improved student achievement. According to Darling-Hammond (2010) and Mardapi et al. (2018), effective measurement of teacher instructional competencies was as important as the development of the competencies. Unfortunately, assessing teacher competencies has not been performed or discussed (Mardapi et al., 2018). According to Smith and Banilower (2015), the assessment of professional knowledge, including PCK, has been "characterized…by uncertainty" (p. 99). However, assessing teacher knowledge should be a component in the development of professional learning programs, because professional development practices should be "based on a deep and thorough investigation" (Aldahmash et al., 2019, p. 173).

Another important aspect of professional development programs included the assessment of the professional development outcomes (Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013). Unfortunately, Kelleher (2003) stated that the use of assessments to measure professional development outcomes was lacking. However, Aldahmash et al.'s (2019) meta-analysis indicated that the use of surveys as an assessment of professional development was on the rise and second only to classroom observation. Regrettably, the reliability of some measures had been lacking (Thurlings & Den Brok, 2017).

In their meta-analysis, Thurlings and Den Brok (2017) found a large majority of measuring instruments had been developed. However, the evaluation of the validity and reliability of the instruments was not presented (Thurlings & Den Brok, 2017). Additionally, reported reliabilities often did not meet reliability standards (Thurlings & Den Brok, 2017). Wilcox (2016) stated confirmation of a measure's validity is not based on an individual study but determined "over multiple studies" (p. 7). Therefore, through this study, the researcher looked to examine further and support the construct validity and reliability of the ATPCK developed by Jang et al. (2009) and utilized by Jang et al. (2009), Jang (2011), and Lucenario et al. (2016). Evaluation for validity and reliability of the ATPCK followed the guidelines presented by the Standards for Educational and Psychological Testing (American Educational Research Association, 2014). The Standards were a collaborative development effort of the National Council on Measurement in Education (NCME) and the American Psychological Association (APA), resulting in the accepted guidelines for designing and developing educational measures (Wilcox, 2016). Determination of construct validity and reliability of the ATPCK as a

self-assessment measure could provide an educational measure to guide and assess professional development outcomes at the school level and potentially at the district level.

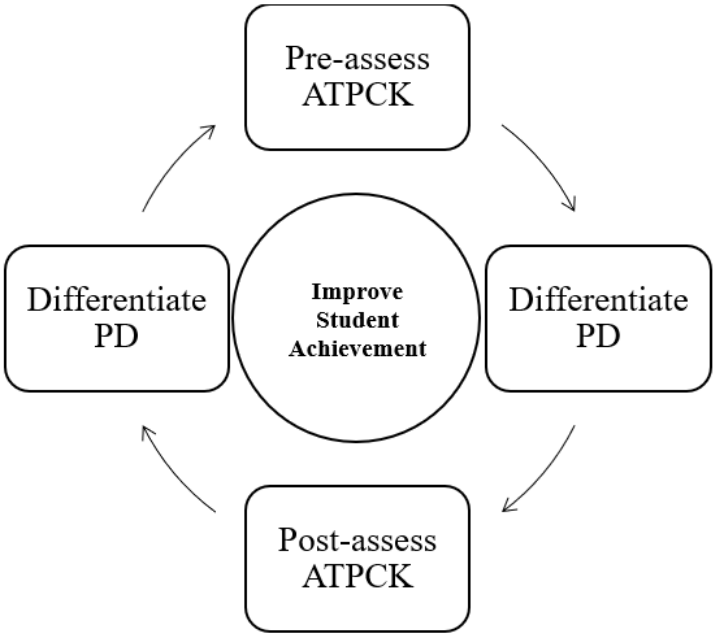


*Figure 1.* A conceptual framework for validation of the ATPCK

## Conceptual and Operational Definitions

The following definitions will be utilized for this study:

- *PCK (Pedagogical Content Knowledge):* Refers to professional knowledge that demonstrates a form of content knowledge (CK) and pedagogical knowledge (PK) that embodies the aspects of content most relevant and to its teachability of the content in its most useful form or representation (Shulman, 1986).
- *Components of PCK:*
    - *Subject Matter Knowledge (SMK)*: Refers to professional knowledge comprehension of content and concepts within that discipline (Jang, 2011).

- *Instructional Objective and Context (IOC)*: Refers to teachers' attitudes, classroom environment and atmosphere, and knowledge of the content's instructional context (Jang, 2011).
- *Knowledge of Students' Understanding (KSU):* Refers to the knowledge of students, before, during, and after lesson presentation (Jang, 2011).
- *Instructional Representation and Strategies (IRS)*: Refers to professional knowledge of the various representative range of content to include, analogies, metaphors, examples, application, and incorporation of these ideas within instructional practices (Jang, 2011).

## Significance of the Study

Studies have shown that professional teacher knowledge, identified as PCK, was a significant contributor to students' academic achievement (Gess-Newsome, 2013). Park and Suh (2015) shared there was a need for valid and reliable PCK measure, so that a relationship between teacher PCK, instructional practices, and student achievement may be identified. Current practices in the identified Title I school district of study allowed each school the autonomy to determine professional learning needs. Minimal district requirements dictated that professional learning opportunities provided must align with each school's School Improvement Plan (SIP). Therefore, professional learning decisions were often based on each school's perceived needs and not necessarily empirical data. Additionally, the impact of professional learning provided was evaluated utilizing a standard perception survey, with no evaluation of the professional learning impact on instructional practices (D. Dykes, personal communication, January 25, 2020).

Evaluation of the ATPCK as a self-assessment measure of the four domains of PCK, as presented by Jang et al. (2009) and Lucenario et al. (2016), was the focus of this research. Though Lucenario et al. (2016) utilized a modified version of Jang et al.'s (2009) ATPCK, confirmation of construct validity and reliability were not re-evaluated. Therefore, the current research utilized confirmatory factor analysis to confirm the construct validity and reliability of the ATPCK, as modified by Lucenario et al. (2016), as a self-assessment measure in the context of ongoing teacher professional development.

## Research Questions

The following research questions will be addressed:

To what extent will the ATPCK measure, when modified for use as a teacher self-assessment, show evidence of:

1. A four-factor structure with seven loading indicators per factor as determined by Jang et al. (2009)?
2. Internal consistency reliability?

## Methodology

The methods included a cross-sectional design utilizing a confirmatory factor analysis (CFA) approach to confirm the validity and reliability of ATPCK as a self-assessment tool for K-12 teachers. Through CFA, the researcher evaluated the four domains of PCK, which served as the latent variables and 28 statements for measured responses, which served as the indicator variables, seven for each of the four latent variables, as shown in Table 1.

Table 1

PCK Latent Factors and Measured Indicators

| **PCK factors** | **Measured indicators** |
|---|---|
| Subject Matter Knowledge | The teacher knows the content he/she is teaching.<br>The teacher clearly explains the content of the subject.<br>The teacher knows how theories or principles of the subject have been developed.<br>The teacher selects the appropriate content for students.<br>The teacher knows the answers to questions that we ask about the subject.<br>The teacher explains the impact of subject matter on society.<br>The teacher knows the whole structure and direction of this SMK. |
| Instructional Objective and Context | The teacher makes me clearly understand the objectives of this course.<br>The teacher provides an appropriate interaction or good atmosphere.<br>The teacher pays attention to students' reactions during class and adjusts his/her teaching.<br>The teacher creates a classroom circumstance to promote my interest in learning.<br>The teacher prepares some additional teaching materials.<br>The teacher copes with our classroom context appropriately.<br>The teacher's belief or value in teaching is active and aggressive. |
| Knowledge of Student Understanding | The teacher realizes students' prior knowledge before class.<br>The teacher knows students' learning difficulties in a subject before class.<br>The teacher's questions evaluate my understanding of a topic.<br>The teacher's assessment methods evaluate my understanding of the subject.<br>The teacher uses different approaches (questions, discussion, etc.) to find out whether I understand.<br>The teacher's assignments facilitate my understanding of the subject.<br>The teacher's tests help me realize the learning situation. |
| Instructional Representations and Strategies | The teacher uses appropriate examples to explain concepts related to the subject matter.<br>The teacher uses familiar analogies to explain concepts of the subject matter.<br>The teacher's teaching methods keep me interested in this subject.<br>The teacher provides opportunities for me to express my views during class.<br>The teacher uses demonstrations to help explain the main concept.<br>The teacher uses a variety of teaching approaches to transform subject matter into comprehensible knowledge.<br>The teacher uses multimedia or technology (e.g., PowerPoint) to express the concept of the subject. |

The ATPCK's construct validity and reliability were initially determined by Jang et al. (2009) and was utilized for college students' perception of teachers' PCK. Although Lucenario et al. (2016) modified the ATPCK from the first-person possessive to third-person neutral and changed the Likert scale from five options to four options, the construct validity and reliability were not determined by Lucenario et al. (2016). For this study, the factors were reworded to reflect first-person for teacher self-assessment purposes: the context of the factors was not modified. Although the instrument was developed as a student assessment of teachers' PCK, the researcher intended to validate and determine the reliability of the ATPCK for use as a teachers' self-assessment to inform and assess professional development practices.

## Limitations

Limitations of this research design included the non-experimental cross-sectional design and restricted sample size involved in the study, resulting in the lack of a control group or randomization. Although the use of this research typology did not allow for the determination of causality, non-experimental research is important in educational research because the manipulation of independent variables could be considered unethical (Johnson & Christensen, 2017). Although the sample size did not allow for exploratory factor analysis, the achieved sample size did support the confirmatory factor analysis of Jang et al.'s (2009) theoretical model. Confirmatory factor analysis practices were utilized by Jang et al. (2009) for validation and determination of reliability of the ATPCK; the achieved sample size allowed for mirrored analysis practices to evaluate Jang et al.'s (2009) validation and reliability results.

Participation in the research was voluntary and may have resulted in unidentified bias. Grade band participation rate may have varied due to participants' familiarity with the researcher, as the researcher has served in both the high school and middle school settings within the research district. Variation of grade band participation rates may have resulted in unidentified bias, although the canonical PCK design of the ATPCK should minimize potential bias. Canonical PCK allowed for evaluation of teacher's PCK "within the particular teaching and learning context" (Jang et al., 2009, p. 603) rather than a particular content and topic. Additionally, the instrument utilized for data collection was designed for educational practices in Taiwan (Jang et al., 2009) and the Philippines (Lucenario et al., 2016) and the use of this instrument in the United States may have resulted in unanticipated cultural biases as well as language translation challenges. Unintended bias may also have occurred as a result of participants' interpretation of the Likert scale variables provided, as no clear descriptor for each scale item was provided (Brinker, 2002). However, minor variances in response data were addressed through standard deviation values and resulted in minimal impact on results (Brinker, 2002).

## Delimitations

The participants in this research were K-12 teachers working in a Title 1 school district located in the southeastern United States. Due to time constraints and access to certified teaching faculty contact information (emails), the research was limited to the district in which the researcher was employed. Though the research was limited to the identified Title I school district, professional development practices are a U.S. Department of Education (2015) requirement and occur nationwide. Additionally, the designation of Title I is not limited to school systems in the southeastern United States

but is a nationwide designation for economically disadvantaged school systems. Therefore, the Title I designation, nor the location of the research target negatively impact the results of this research.

## Summary

Teacher quality has become a focus of national concern. Because PCK has been shown to impact student engagement and achievement significantly, this study was designed to confirm the construct validity and reliability of the ATPCK as a self-assessment through CFA. Park and Suh (2015) communicated that there was a need for valid and reliable PCK measures so that a relationship between teacher PCK, instructional practices, and student achievement may be identified. The findings of this research confirmed the construct validity and reliability of the ATPCK as a self-assessment measure of the four domains of PCK, as presented by Jang et al. (2009) and Lucenario et al. (2016). Validation of the ATPCK as a self-assessment measure could provide for guiding professional learning and assessment of professional development outcomes at the school level and potentially at a district level.

# CHAPTER II

# LITERATURE REVIEW

Education reform can be traced back to the Sputnik era of the 1950s when the focus on science and math curriculum in the United States transformed into a governmental asset (Basile & Lopez, 2015). In the aftermath of the 1983 *Nation at Risk*, efforts to establish ambitious learning objectives were launched for America's youth resulting in reform efforts, multiple research studies, and a commissioned publication, hoping to develop an understanding of student learning processes (Coburn, Hill, & Spillane, 2016). Langrall (2016) shared that the National Council of Teachers of Mathematics (NCTM) released the *Curriculum and Evaluation Standards for School Mathematics* in 1989. These standards were grade-level specific and designed around inquiry and solving real-world problems (Langrall, 2016). Lederman and Lederman (2016) believed that knowledge gained through inquiry displayed specific characteristics that are reflective of how the knowledge is added. Unfortunately, according to Bhattacharyya, Mead, Junot, and Welch (2013), Kelly (2016), and Pérez and Furman (2016), implementation of inquiry practices without a practical framework created challenges and may result in limited learning (Bhattacharyya et al., 2013; Kelly, 2016; Pérez & Furman, 2016). During the late 1980s through the 2000s, state standards became the focus for assessment and professional development (Coburn et al., 2016; Langrall, 2016). Educational reforms have further resulted in changes in curriculum and the use of innovative pedagogical methods (Aydeniz & Kirbulut, 2014; Lederman & Lederman, 2016; Stuckey, Hofstein, Mamlok-Naamon & Eilks, 2013).

Educators lacking a strong curriculum design background faced challenges in the development and utilization of context-based curricula (de Putter-Smits, 2012). Lederman and Lederman (2016) stated that teachers must continually and collaboratively discuss the curriculum and pedagogy to ensure students' ability to make educated choices regarding social and personal matters. Marco-Bujosa, McNeill, González-Howard, and Loper (2016) stated part of the challenge might be related to teachers' views that curriculum was a source of activities rather than a professional development guide created to engage teachers in their own learning goals. Houseal, Abd-El-Khalick, and Destefano (2014) expressed that teachers must command "both the substantive and syntactic dimensions of their disciplines" (p.85). However, some researchers considered teachers' professional knowledge, or PCK, as a key component in improving students' interests in math and science as well as students' overall academic achievement (Aydeniz & Kirbulut, 2014; Bouchard, 2015; Shulman, 1986; Shulman, 1987). Because PCK is a unique knowledge for teachers, there has been an increased interest in education research for this unique teacher knowledge and how best to grow this teacher knowledge (Gess-Newsome, 1999). In a quasi-experimental, cross-sectional longitudinal study Kunter et al. (2013) found that teacher competency impacted not only student outcomes but also student enjoyment for the content. Kunter et al.'s (2013) research indicated that teacher competencies directly impacted quality instructional practices, and PCK was directly related to supporting student learning. Hence, Kunter et al. (2013) identified a need for continued educational research focused on improving the unique teaching knowledge of PCK.

## Professional Knowledge

Assessing the content knowledge and pedagogy competency of teachers was another focus of educational reform (Shulman, 1986). The domain of content knowledge (CK) required thinking beyond the constraints of the field; CK required being able to go beyond the facts and basic concepts of an identified content (Shulman, 1986). This insight resulted in Shulman's (1986) identification of the *missing paradigm* in professional knowledge, PCK. Since the introduction of PCK, there has been growing research interest in how to best assess this teacher's knowledge base (König et al., 2016). Most of the current research regarding the assessment of PCK had been centered on the teaching of mathematics, and science content with many of these studies focused on topic-specific content (Hill, Ball, & Schilling, 2008; Kelly & Kelly, 2016; Kirschner et al., 2016; Lee & Shea, 2016; Lucenario et al., 2016). However, the implications of PCK and its value have now expanded to include teaching English as a foreign language (König et al., 2016).

Since the identification of PCK, multiple researchers have worked to identify and refine the different dimensions of teachers' professional knowledge (Smith & Banilower, 2015; Park & Suh, 2015; Kind, 2015). Mitcheltree (2006) identified PCK to include the teaching mechanisms of lesson planning, classroom management, and assessment. Kirschner et al. (2016) distinguished the dimensions of professional knowledge as CK, pedagogical knowledge (PK), and PCK.

Gess-Newsome (2013) stated that research has shown that PCK occurs on a continuum, and differing levels of CK resulted in differing instructional practices. The domain of CK requires thinking beyond the constraints of the field; it requires going

beyond the facts and basic concepts of an identified content. Research presented by Baumert et al. (2010) indicated that though CK was a precursor to PCK, teacher CK was a poor indicator of student achievement whereas, PCK had "greater power" (p. 163) as an indicator of student achievement and was more "decisive" (p. 163) for quality teaching. Baumert et al.'s (2010) research utilized hierarchal structural equation modeling practices to evaluate the impact of CK as well as PCK (independent variables) on student achievement (dependent variable). The study utilized an age/grade based cross-sectional longitudinal design consisting of 181 teachers and 4,353 students to evaluate the impact of CK and PCK on student outcomes in tenth-grade mathematics (Baumert et al., 2010). These research results supported Gess-Newsome's (2013) hypothesis that CK was a precursor to PCK. However, Baumert et al.'s (2010) research findings indicated that PCK was a stronger predictor of student success than CK.

König et al. (2016) evaluated the role of PK and its relationship to both CK and PCK. Utilizing confirmatory factor analysis practices, König et al. (2016) evaluated a three latent variable model of teacher knowledge; CK, PCK, and PK. König et al. (2016) assessed CK, PCK, and PK, utilizing three separate assessments. Assessment of CK was performed utilizing a valid and reliable assessment for teachers of English as a foreign language (TEFL); the assessment for PCK was developed through pilot studies and expert review, resulting in a total of 33 questions (König et al., 2016). For the PCK assessment, three domains were identified: curriculum, instructional strategies, and knowledge of students (König et al., 2016). To assess PK, an assessment was developed based on the Teacher Education and Development Study in Mathematics (TEDS-M) for which validity and reliability had been determined (König, Blömeke, Paine, Schmidt, &

Hsieh, 2011; König et al., 2016). König et al.'s (2016) results indicated a higher intercorrelation between CK and PCK than the intercorrelation of PCK and PK, and PK was more intercorrelated with PCK than it was with CK. Baumert et al.'s (2010) and König et al.'s (2016) research indicated PCK was, in fact, a stand-alone professional knowledge, and this knowledge positively impacted student achievement.

In 2012, multiple PCK researchers convened at a PCK Summit to discuss PCK research and PCK's impact on teaching and learning (Berry, Friedrichsen, & Loughran, 2015). One of the goals of the summit was to develop a consensus as to the definition of PCK (Berry et al., 2015). During his opening keynote address at the PCK Summit in 2012, Shulman presented several shortcomings of the original PCK ideology. Gess-Newsome (2015) shared that PCK was not only a piece of knowledge, as represented in teachers' instructional planning, but also a skill, the ability to monitor student engagement and understanding, and then adjust instructional practices as and when needed. The skill for PCK was identified as pedagogical content knowledge and skill (PCK&S). Gess-Newsome (2015) reported that the consensus definitions of PCK and PCK&S are:

> Personal PCK is the *knowledge* of, *reasoning* behind and *planning* for teaching a particular *topic* in a particular *way* for a particular *purpose* to particular *students* for enhanced *student outcomes*. (Reflection *on* Action, Explicit) (p. 36).
>
> Personal PCK&S is the *act of teaching* a particular *topic* in a particular *way* for a particular *purpose* to particular *students* for enhanced *student outcomes*. (Reflection *in* Action, Tactic or Explicit) (p. 36).

In response to growing interest in PCK, Kirschner et al. (2016) developed a model demonstrating the relationship between CK, PCK, and PK (Figure 2). This model characterized these knowledge domains as being on a continuum, where CK and PCK and PCK and PK are more closely related than CK and PK (Figure 1) (Kirschner et al., 2016; Gess-Newsome, 2013). Additionally, the growing interest resulted in empirical evidence exposing teachers' CK, command of pedagogy (PK), and understanding of students as learners, which has a combined impact on student achievement (Barnett, 2015; Hill et al., 2008; König et al., 2016). As a result of their research, Kirschner et al. (2016) postulated the need for targeted professional development in the area of PCK to support pre-service and in-service teachers as a means to improve student achievement.

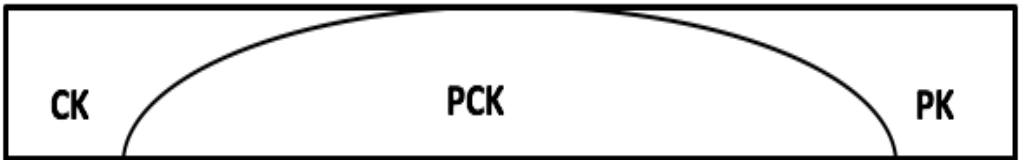


*Figure 2.* Kirschner et al., (2016) model for a continuum of professional knowledge domains, content knowledge (CK), pedagogical content knowledge (PCK), and pedagogical knowledge (PK).

Glowinski (2015) advanced that pre-service teachers' professional knowledge base reflected the quality of their respective teacher preparation programs. The effective characteristics of quality teacher preparation programs incorporated the length and intensity of specific content areas of programs, to include a PCK course (Glowinski, 2015). Evens et al. (2015) identified PCK courses as effective interventions, along with student teaching opportunities. However, Evens et al.'s (2015) meta-analysis also stated that PCK interventions are more effective when "the intervention was organized by researchers than if regular teachers organized it."(p. 9). Researchers further suggested the need for an investigation to ascertain the types of support that mentor teachers

required to encourage reform-based instructional practices to positively impact pre-service teachers' development of PCK (Barnett, 2015; Bradbury, 2010). However, Abell, Rogers, Hanuscin, Lee, and Gagnon (2009) stated teachers' professional learning needs to be changed as their PCK knowledge developed and learning occurred in context, allowing teachers to become participants in community practices. These findings implied that veteran educators' PCK development required differentiated professional learning opportunities (Abell et al., 2009).

## Professional Development

Refining teacher professional development as an educational reform has become a compelling argument for improving instructional practices that may lead to increased student achievement (Akiba & Liang, 2016). Trust, Krutka, and Carpenter (2016) stated that traditional professional development failed to meet the "needs of classroom teachers" (p. 6). Additionally, researchers showed that large-scale professional development programs did not improve teacher "knowledge, instruction.…or student achievement" (Akiba & Wilkinson, 2016; Garet et al., 2011; Newman et al., 2012). Short workshops or seminars presented by independent educational specialists often lacked depth and may have resulted in a "problem of enactment" (p. 947) (Kennedy, 2016; Trust et al. 2016). Kennedy (2016) described the *problem of enactment* as an educator's struggle to take what was learned outside of the classroom and enact the practice within the classroom. Because traditional professional development generally addressed a narrow vision of teacher learning and often resulted in the *problem of enactment*, teachers did not believe that current professional development practices met their professional needs (OECD, 2014). Allowing teachers to co-construct their professional knowledge through

collaboration with peers and colleagues may support the individual professional needs of teachers (Trust et al., 2016). Additionally, empirical research showed teacher collaboration, in the form of professional learning communities (PLC), had a positive impact on student achievement (Akiba & Liang, 2016).

According to Stoll and Louis (2007), "there is no universal definition of a professional learning community" (p. 2). Wynn (2019) shared the state of Georgia, as recently as 2017, did not provide for a definition of PLCs, though participation in PLCs is a requirement for teacher certification renewal. However, the phrase itself described the nature of a PLC; the term professional indicated a focused and technical knowledge, learning indicated a change in focus from process towards improvement in practice, and community indicated that teachers were working collaboratively towards a common instructional outcome and making "a difference for students" (Stoll & Louis, 2007, p. 3).

Arminio and Torres (2012) noted that the nature of effective PLCs allowed for empathy and acceptance, which in turn encouraged individuals to work collaboratively to develop new meaning and new approaches to a common outcome. Findings indicated that strong, collaborative professional development communities resulted in improved instructional practices and school reform efforts (Arminio & Torres, 2012). Creating effective PLCs resulted in teachers using higher-order thinking tasks, which in turn resulted in improved student problem solving and communication of content understanding (Borko, 2004). All of these findings supported teachers' PCK was strengthened through what Smith and Banilower (2015) characterized as "collective expert wisdom of practice" (p. 90). Smith and Banilower (2015) discussed the need for assessment of teacher knowledge in the form of PCK and how this knowledge impacted

student learning. However, the assessment of PCK had proven to be a challenge (Ayendiz & Demet, 2014; Jang et al., 2009; Park & Suh, 2015; Smith & Banilower, 2015).

## Assessing PCK

Establishing an explicit link between teachers' professional knowledge and instructional practices and how professional development of these components impacted teachers' PCK had been elusive in the absence of empirical testing (Aydeniz & Demet 2014; Loewenberg Ball et al., 2008). Though instruments have been developed to measure PCK, these PCK assessments tend to be content and topic-specific assessments, such as the content representations (CoRe) and pedagogical and professional-experience repertoires (PaP-eRs), the *Science Teachers Learning from Lesson Analysis* (STeLLA), and the ProwiN project physics section (Cooper, Loughran, & Berry, 2015; Kirschner, Taylor, Rollnick, Borowski and Mavhunga, 2015). For mathematical content, researchers conducted studies such as the Mathematics Knowledge for Teaching studies (MKT), Cognitive Activation in the Classroom (COACTIV) and Teacher Education and Development Study in Mathematics (TEDS-M) intending to develop a valid and reliable measure of PCK (Kazemi & Rafielpour, 2018). For both science and math, these topic-specific assessments came in many forms from multiple-choice and open-ended question type tests to viewing of videos then responding, as well as interview practices and coding schemes designed for video-recorded lessons (Kirschner et al., 2015). However, the assessment practices presented are aligned with what Park and Suh (2015) referred to as topic-specific PCK (TSPCK) rather than canonical (or normative) PCK (Smith & Banilower, 2015). Canonical PCK allowed for evaluation of teacher's PCK "within the

particular teaching and learning context" (Jang et al., 2009, p. 603) rather than a particular content and topic.

Another challenge in developing measures for teacher PCK was the lack of consensus on a clear definition as well as the components that make up the construct PCK (Aydeniz & Demet, 2014; Kirschner et al., 2015; Park & Suh, 2015; Schneider, 2015; Smith & Banilower, 2015). Park and Suh (2015) identified two components which they labeled KSU and knowledge of instructional strategies and representations (KISR). Whereas, Smith and Banilower (2015) suggested the components of PCK were content knowledge, pedagogical knowledge, instructional strategies for conceptual learning, and knowledge of assessment strategies. However, other researchers, Daehler, Heller, and Wong (2015), focused their research on three components; 1) organization of instruction, 2) understanding preconceptions, misunderstandings, and addressing the range of student understanding, and 3) plan instruction to support the development of student understanding.

Jang et al. (2009) initially developed a survey instrument designed to measure three variables of PCK: "instructional representation," strategies, and assessment of students' prior knowledge" (p. 599). However, the exploratory factor analysis did not support the three-factor model but supported a four-factor model. Following the initial pilot study, Jang et al. (2009) interviewed teachers and collaborated with the Advancing Teachers' Teaching Excellence Committee (ATTEC) and found an overlap in instructional representations and strategies, as well as determined that the context for instruction had been overlooked. Through ongoing collaboration with ATTEC and participating teachers, the ATPCK was developed. A Google Scholar and Galileo search

resulted in no additional information regarding the ATTEC. The final measurement tool consisted of four latent variables within the professional knowledge of PCK: SMK, IOC, KSU, and IRS (Jang et al., 2009). For each identified factor of PCK, the researchers, ATTEC, and participating teachers developed seven indicator measures for each of the factors which were measured on a one-to-five Likert scale: never, seldom, sometimes, often, and always (Jang et al., 2009). Through confirmatory factor analysis practices, the four identified PCK factors and 28 total indicators, seven for each factor, demonstrated construct validity and reliability resulting in the final ATPCK survey (Jang et al., 2009).

Park, Suh, and Seo (2018) stated that PCK had a "reciprocal and nurturing" (p. 551) relationship with PK, SMK, and knowledge of context. Although researchers (e.g., Grossman, 1990; Park et al., 2018; Shulman, 1986) identified SMK as a separate knowledge from PCK, Loewenberg Ball et al. (2008) distinguished "pure" (p. 396) SMK as not including knowledge of students as learners or pedagogical knowledge. Due to the lack of consensus on a clear definition of PCK and the domains that make up the professional knowledge, the four latent variables presented reflect the descriptions provided by Jang et al. (2009) and utilized for the development of the ATPCK.

Though Sadler et al. (2013) described SMK as a "general conceptual understanding" (p.1022) of content knowledge, the definition provided by Jang et al. (2009) was more descriptive. Jang et al. (2009) shared SMK was how the teacher was able to convey a conceptual understanding of their content through the construction, and the "structure and direction" (p. 599) of the content knowledge conveyed. In the context of the ATPCK, measures for the latent variable, SMK, reflected a need for knowledge of students (e.g., The teacher selects the appropriate content for students) (Jang et al., 2009).

Therefore, SMK was treated as a latent variable of PCK rather than as a separate *pure* SMK (Loewenberg Ball et al., 2008). Unfortunately, according to Sadler et al. (2019), empirical evidence supporting the impact of teacher SMK on student achievement had been "conspicuously absent" (p. 1023), potentially backing Jang et al.'s (2009) inclusion of SMK as a variable of PCK, substantiating the need for the validation of the ATPCK.

Instructional objective and context (IOC) was an additional latent variable of PCK identified by Jang et al. (2009) in the development of the ATPCK. As with SMK, Jang et al.'s (2009) research indicated that IOC was a latent variable reflective of PCK, rather than a stand-alone knowledge. No research discussing IOC in the context of PCK was identified through a Galileo search completed on November 26, 2019. Therefore, Jang et al.'s (2009) definition of IOC was presented. Jang et al. (2009) described IOC as knowledge of the objectives and progression of education. IOC supports interaction with the curriculum, teacher's attitudes, classroom management strategies, understanding the value of school setting, and the intention of and for instruction (Jang et al., 2009). The definition of IOC, as evaluated by the ATPCK, aligned to Shulman's (1987) knowledge of educational context. Shulman (1987) described knowledge of educational context as "ranging from the workings of the group or classroom, the governance and financing of school districts to the character of communities and cultures" (p. 8). Due to the lack of research regarding IOC as an independent knowledge, Jang et al.'s (2009) treatment of the knowledge as latent-variable of PCK was validated.

An additional teacher knowledge that Shulman (1987) discussed was that of knowledge of students. Though Shulman (1987) identified knowledge of students as knowledge independent of PCK, Shulman's (1986) description of PCK included

knowledge of student preconceptions, misunderstandings, and background knowledge for the content being taught. Shulman's (1986) description of PCK supported Jang et al.'s (2009) definition in the context of the ATPCK. Jang et al. (2009) shared that KSU was the ability of teachers to assess and evaluate students' progression towards mastery of knowledge as a result of provided instruction. Additionally, Park et al. (2018) developed a valid and reliable measure of KSU as one of the components of PCK. Therefore, the evaluation of the validity of the ATPCK was needed to determine further if KSU was a latent variable of PCK or acted as a stand-alone knowledge.

The final teacher knowledge of PCK presented by Jang et al. (2009) was IRS. A Galileo search resulted in the identification of only one additional reference to IRS; Kazemi and Bayat (n.d.) provided no additional context or definition of the IRS. Kazemi and Bayat (n.d.) measured the IRS as a component of PCK, similar to how Jang et al. (2009) measured the IRS. However, rather than utilizing seven indicators, Kazemi and Bayat (n.d.) utilized three similar indicators but modified from those used by Jang et al. (2009) in the ATPCK. An example included "[t]eachers' capability in using right examples and illustration to make the explanation clear" (Kazemi & Bayat, n.d., p. 75) versus "My teacher uses appropriate examples to explain concepts related to the subject matter" (Jang et al., 2009, p. 606). Similar to Jang et al. (2009), the instrument used by Kazemi and Bayat (n.d.) utilized a Likert scale of one-to-five to measure their indicators: never, seldom, sometimes, often, and always. However, Kazemi and Bayat's (n.d.) instrument was utilized as an observation tool rather than as a survey instrument. Because the current research intended to validate the ATPCK as a self-assessment survey, Jang et al.'s (2009) definition for IRS was utilized. Jang et al. (2009) defined the

IRS as the scope of the teacher's use of formative and summative assessments to evaluate student understanding before, during, and following instruction.

Although Smith and Banilower's (2015) attempts at developing a PCK measure were "characterized by uncertainty" (p. 88), the work of Jang et al. (2009) had successfully developed a valid and reliable measure of canonical PCK, the ATPCK. Jang et al. (2009) stated that the ATPCK allowed evaluation of a teacher's PCK "within the particular teaching and learning context" (p. 603), rather than content and topic-specific measures. Following the development of the ATPCK, Jang (2011) and Lucenario et al. (2016) utilized the measure as a pre- and post-assessment of college students' perceptions of teachers' PCK. Though the use of this measure had been applied as a pre- and post-assessment since development, additional discussion, and evaluation of construct validity and reliability data were not presented (Jang, 2011, Lucenario et al., 2016). Therefore, the current research was intended to confirm the ATPCK's construct validity and reliability as a self-assessment to inform professional development practices.

## Validity and Reliability

The necessity of valid and reliable survey instruments spanned multiple industries of research to include, but not limited to, business, marketing, industry, education, medical, and psychosocial research. A literature search for *psychometric or validity or reliability* resulted in the identification of health and social sciences, as well as applied research, to include educational research as an application of psychometric practices.

### Validity

Validity was used to determine "the degree to which evidence and theory support the interpretation of test scores" (American Educational Research Association, 2014,

p.9). For example, did a stoichiometry assessment measure a student's knowledge of stoichiometry or knowledge of mathematical practices applied within this chemistry concept? The American Educational Research Association (2014) guided in addressing the required evidence needed to demonstrate validity: the content of the assessment, response types, internal structure, interactions with different variables, and intentions of assessment. Due to the lack of observability of validity, a measure must provide for the five pieces of evidence presented (American Educational Research Association, 2014). Evaluation of validity can be performed utilizing structural equation modeling (SEM) (Wang & Wang, 2012). SEM provides for a general analytical framework by incorporating the measurement of factor analysis and the structural approach of path analysis, focusing on latent unobserved variables rather than observed, measured variables (Wang & Wang, 2012).

With structural equation modeling (SEM), a model utilizing path diagrams was first developed. The model indicated the interactions of both measured and latent variables; measured variables are depicted as circles and latent variables as rectangles, straight lines are used to show causal effects and curved lines to show correlations (Schreiber, Nora, Stage, Barlow, & King, 2006; Wang & Wang, 2012). The proposed model was then evaluated to ensure that the observed data provided a unique value for all unknown parameters (Wang & Wang, 2012).

When initially developing a measure, exploratory factor analysis (EFA) was utilized to determine factorial structures within the measure, while CFA was used to evaluate existing theory-based or evidenced-based factorial structures (Schreiber et al., 2006; Wang & Wang, 2012). Because the validity of the ATPCK had been determined

as a student evaluation measure, EFA was not utilized. However, Jang et al.'s (2009) theoretical model was evaluated as a self-assessment rather than as a student perception measure with K-12 Georgia certified teachers in a Title I school district utilizing CFA (Jang et al., 2009).

To best estimate the model, SEM minimized differing residuals between a sample and estimated model variances/covariances (Wang & Wang, 2014). The next model fit was determined by evaluating the differences between the estimated model and observed sample variances/covariances matrices (Wang & Wang, 2014). Finally, a model modification was considered, depending on the outcome of the fit analysis, and model "re-specification" was utilized based on either a theory basis or empirical conclusions (Wang & Wang, 2014). Upon determination of the validity of a measure, the reliability of the instrument was also evaluated.

Reliability

When an instrument consistently measures a variable when applied under similar circumstances and does so repeatedly, the instrument was determined to be considered reliable (Heale & Twycross, 2015). Unfortunately, Graham (2006) shared that measurement design was often disregarded in educational research resulting in the lack of basic knowledge to "accurately estimate reliability" (p. 930). However, determining reliability was an important step in confirming the validity of a measurement instrument (Graham, 2006; Wilcox, 2016).

For this research, internal consistency was utilized to determine the reliability of the ATPCK as published (Jang et al., 2009). The reliability of the ATPCK was reported as a Cronbach's alpha value greater than .871 (Jang et al., 2009). Due to the lack of

discussion regarding the essential tau-equivalent measurement model, Jang et al.'s (2009) published that reliability could underestimate the true reliability of the ATPCK (Graham, 2006). Therefore, the current research estimated reliability utilizing a hierarchal model beginning with congeneric (least parsimonious) through parallel (most parsimonious) models as described by Graham (2006). Trizano-Hermosilla and Alvarado (2016) stated that if the assumption of tau-equivalence (equal factor loading values per latent variable) were violated, then Cronbach's alpha would underestimate reliability. Therefore, Raykov's rho was also utilized to determine reliability. Raykov's rho had been identified as an appropriate reliability calculation when utilizing confirmatory factor analysis (Arifin, 2017). In confirming the validity and reliability of the ATPCK, the current findings provided an assessment that could link PCK, directly to student achievement.

## Assessing Professional Development Practice

Establishing an explicit link between teachers' professional knowledge and instructional practices and how professional development of these components impact teachers' PCK had been elusive in the absence of empirical testing (Aydeniz & Demet 2014; Loewenberg Ball et al., 2008). Additionally, refining teacher professional development as an educational reform had become a compelling argument for improving instructional practices that lead to increased student achievement (Akiba & Liang, 2015). In support of improving teacher knowledge such as PCK, professional development practices must be refined to support such development. The current research proposed the utilization of the ATPCK, when used as a self-assessment, a valid and reliable pre-assessment to guide professional learning opportunity development, a formative

assessment, ensuring the learning focus, and a post-assessment to determine the effectiveness and next steps in an ongoing professional development cycle.

Utilizing the ATPCK as a pre-assessment will allow for differentiation of professional development to the needs of the teachers, whether at a district, school, or PLC level. Mahammadi and Moradi's (2017) findings indicated that differentiating professional development practices are advantageous to teachers' buy-in to the professional learning opportunities presented. When teachers believed their individual needs were being addressed, their perception and performance were positively impacted, resulting in improved instructional practices and thereby improved student achievement (Mahammadi & Moradi, 2017). Additionally, though often a mandate of professional development, PLCs provided adaptability of the learning experience to the specific context and needs of the individuals within that PLC, resulting in improved teacher commitment and contribution to the learning process (Trust et al., 2016). According to Darling-Hammond (2010) and Mardapi et al. (2018), effective measurement of teacher instructional competencies was as important as the development of the competencies. Regrettably, assessing teacher competencies was not often performed or discussed (Mardapi et al., 2018). According to Smith and Banilower (2015), the assessment of professional knowledge, including PCK, had been "characterized…by uncertainty" (p. 99). Blitz and Schulman's (2016) lack in identifying an assessment evaluating teachers' knowledge growth provided support for the need to validate the ATPCK as an assessment of teachers' professional knowledge growth in the form of PCK.

The effectiveness of PLCs must be evaluated to ensure teachers are utilizing their learning in practice as well as that PLCs are continually and effectively supporting the

needs of teachers (Blitz & Schulman, 2016). Although Blitz and Schulman (2016) identified 49 different PLC assessment tools, none of these tools evaluated the effectiveness of PLCs on the growth of teacher PCK. Although, Aldahmash et al.'s (2019) meta-analysis indicated the use of surveys as an assessment of professional development was on the rise and second only to classroom observation. As a means of assessing professional development effectiveness, Jang et al. (2009), Jang (2011), and Lucenario et al. (2016) utilized the ATPCK as a pre- and post-survey of college students' perception of their teachers' PCK. The ATPCK was administered before professional development interventions provided and then utilized as a post-assessment to determine the effectiveness of the professional development intervention provided (Jang et al., 2009; Jang, 2011; Lucenario et al., 2016). Unfortunately, only Jang et al.'s (2009) initial research provided data for construct validity and reliability of the ATPCK. Therefore, validation of the ATPCK as a survey instrument was re-evaluated as a self-assessment of teachers' PCK.

Another factor in professional development assessment was the need to provide outcome data to stakeholders. The U.S. Department of Education, through its Improving Teacher Quality State Grants, provided financial support for professional development. In order to receive this funding source, the local districts were required to show improved student achievement (Department of Education, 2015). However, most student achievement measurers provided lagging data to community and district level stakeholders. Through the validation of the ATPCK, this study provided a professional development assessment tool that would deliver valid outcome data for community and district level stakeholders for evaluation of a professional development program's

effectiveness; thereby, guiding professional development decision-making practices at a district level.

Establishing an explicit link between teachers' professional knowledge, instructional practices, and how these components impacted teachers' PCK had been elusive in the absence of empirical testing (Aydeniz & Demet 2014; Loewenberg Ball et al., 2008). Additionally, refining teacher professional development as an educational reform had become a compelling argument for improving instructional practices that may lead to increased student achievement (Akiba & Liang, 2016). To ensure the effectiveness of ongoing professional development programs, differentiation of professional development, formative evaluation of the professional development practices, and evaluation of the outcomes resulting from professional development practices must be determined (Blitz & Schulman, 2017; Wynn, 2019). The validation of the Assessment of Teachers' Pedagogical Content Knowledge as a self-reporting instrument provided a key component to quality professional development program development practices.

## Summary

With an unending focus on student academic outcomes and as part of the educational process, leaders persistently reflect on the impact of various educational reforms (Coburn et al., 2016; Shulman, 1986). In the decades since the Sputnik era of the 1950s, the efforts to improve student learning and achievement have taken multiple directions, from the big picture of the high-quality curriculum to the pedagogical and instructional practices, as well as the knowledge base of the individual educator. However, these reforms were limited in their overarching impact on student learning. Therefore, research evaluation of teacher quality, their knowledge and understanding of content, pedagogy, and students as learners, and our ability to assess this knowledge were imperative. These educator attributes are identified as PCK. Table 2 highlights studies that evaluated educators' PCK and how this professional knowledge may be measured to assist educators in their improvement of Shulman's (1986) *missing paradigm* in teacher knowledge, pedagogical content knowledge. As a result of the literature reviewed, this study utilized the findings of the research presented to determine construct validity and reliability as a self-assessment measure for the Assessment of Teachers' Pedagogical Content Knowledge to guide professional development practices, both at a school and district level.

Table 2

*Concept Analysis for Validation of the Assessment of Teachers' Pedagogical Content Knowledge*

| STUDY | PURPOSE | PARTICIPANTS | DESIGN/ ANALYSIS | OUTCOMES |
|---|---|---|---|---|
| Aydeniz, M., & Kirbulut, Z.D. (2014) | Designing an assessment to measure and enhance pre-service teachers' topic-specific PCK. | 30 pre-service chemistry teachers | Qualitative/quantitative: Questionnaire – open-ended independent responses – group discussion of responses/numerically coded quality of response | Provided a "shared language" for pre-service teachers.<br>Developed deeper understanding of reform-based curriculum, instruction, and assessment<br>Realized their limited CK of topic |
| Borko, H. (2004) | Meta-analysis of current teacher professional development (PD) practices and development of affect PD. | "Small number of high-quality professional development programs" (p. 4). | Meta-analysis using multiple conceptual perspectives and multiple units for analysis from a situational perspective. | Three phases of development to support high-quality professional development. |

(*Continues*)

Table 2 (continued)

*Concept Analysis for Validation of the Assessment of Teachers' Pedagogical Content Knowledge*

| STUDY | PURPOSE | PARTICIPANTS | DESIGN/ ANALYSIS | OUTCOMES |
|---|---|---|---|---|
| Evens, M., Elen, J. & Depaepe, F. (2015) | Determining how PCK studies and interventions were designed as well as what elements of the interventions contributed to PCK development. | Three databases (ERIC, Web of Science, and PsycInfo), Five combinations of search terms resulting in 2358 search hits | Meta-analysis | Mostly primary or secondary education, almost three-fourths of studies in natural sciences<br>Interventions addressed PCK sources through PCK courses, contact with cooperating teachers, teaching experience, and reflection. The least addressed sources were content knowledge and observation<br>Most effective interventions occurred either off-site or combination of off/on-site guided by an expert rather than a classroom teacher. |

(*Continues*)

Table 2 (continued)

*Concept Analysis for Validation of the Assessment of Teachers' Pedagogical Content Knowledge*

| STUDY | PURPOSE | PARTICIPANTS | DESIGN/ ANALYSIS | OUTCOMES |
|---|---|---|---|---|
| Gess-Newsome, J. (2015) | Discussion of pedagogical content knowledge research and how this research has resulted in the Teacher Professional Knowledge and Skill (TPK&S) Model. | 22 science educators from 11 research teams and seven countries. | Review essay | The development of the TPK&S model will support targeted professional development opportunities. |
| Jang, S., Guan, S., & Hsieh, H. (2009) | Development of a PCK measure. | 182 college students. | Quantitative exploratory and confirmatory factor analysis. | A valid and reliable measure for PCK. |

(*Continues*)

Table 2 (continued)

*Concept Analysis for Validation of the Assessment of Teachers' Pedagogical Content Knowledge*

| STUDY | PURPOSE | PARTICIPANTS | DESIGN/ ANALYSIS | OUTCOMES |
|---|---|---|---|---|
| Lucenario, J., Yangco, R., Punzalan, A., & Espinosa, A. (2016) | Investigating the use of lesson studies as an intervention in developing pedagogical content knowledge. | Four chemistry teachers, along with their students from two regular public high schools in the Philippines. | Quasi-experimental mixed methods. The quantitative data collected was then inductively analyzed through parametric testing and gap-closing. The qualitative data analysis practices utilized were closely aligned with those of Phenomenology. QUANT → qual → QUANT | Pedagogical content knowledge lesson studies resulted in a positive increase in teachers' pedagogical content knowledge. |
| Mithcheltree, M. (2006) | Understand the progression of teacher knowledge through lesson study practices. | Four secondary math teachers with varied educational background and teaching experience. | Qualitative: Interviews, observations, videotapes, meeting notes and journal reflections were coded analyzed using Grounded Theory | Lesson studies as professional development add to teachers' multi-faceted knowledge base. |

(*Continues*)

Table 2 (continued)

*Concept Analysis for Validation of the Assessment of Teachers' Pedagogical Content Knowledge*

| STUDY | PURPOSE | PARTICIPANTS | DESIGN/ ANALYSIS | OUTCOMES |
|---|---|---|---|---|
| Shulman, L. (1986, 1987) | Discussion of teacher knowledge types and research practices to identify this knowledge | None | Review essay | Identified the teacher knowledges and the "missing paradigm" knowledge identified as pedagogical content knowledge. Discussion of research practices evaluating knowledge. |

# CHAPTER III

# METHODOLOGY

Because measuring teacher's pedagogical content knowledge (PCK) has been described as "complex" (Smith & Banilower, 2015), the purpose of this research was to evaluate the construct validity and reliability of the ATPCK. The construct validity and reliability of the ATPCK were examined as a self-assessment tool for public K-12 school teachers within a Title I school district. The following questions were addressed:
To what extent will the ATPCK measure, when modified for use as a teacher self-assessment, show evidence of:

1. A four-factor structure with seven loading indicators per factor as determined by Jang et al. (2009)?
2. Internal consistency reliability?

## Research Design

To obtain self-assessment ratings from the Georgia Professional Standards Commission (GaPSC) certified teachers at various grade levels, a non-experimental cross-sectional design was utilized. Johnson and Christensen (2017) stated that the advantage of non-experimental cross-sectional research was the allowance for data collection across multiple group types at one time, or once during a short window of time. Non-experimental research allowed for observational research that occurred in a natural setting resulting in inferences regarding observed relationships between variables (Johnson & Christensen, 2017). Although the use of this research typology does not allow for the determination of causality, non-experimental research is important in

educational research because the manipulation of independent variables could be considered unethical (Johnson & Christensen, 2017).

## Participants

The research target was a public K-12 Title I school district located in suburban Atlanta, Georgia. With an economically disadvantaged population of 58.9%, the district consisted of 38 campuses, including 23 elementary schools, eight middle schools, five high schools, one alternative school and one career academy (hcbe.net, 2019). Approximately 69.6% of the elementary schools, 62.5% of middle schools, and 60.0% of high schools were classified as Title 1 schools. The selection of the sample for construct validation and reliability of the ATPCK was chosen utilizing purposive sampling techniques. The participants included 264 GaPSC certified teachers from 17 different schools in the identified district; eight primary/elementary, five middle schools, and four high schools. The sample size indicator ratio was 9:1, with an initial target value of 10:1 (Everitt, 1975). However, due to the empirically determined high commonality of the survey indicators, as well as the overdetermination of the latent variables (7:1), the impact of sample size was minimized (Hogarty et al., 2005; MacCallum, Widaman, Zhang & Hong, 1999).

## Instrumentation

The ATPCK was initially developed by Jang et al. (2009) and was additionally used by Lucenario et al. (2016). The instrument was developed to measure teachers' PCK as perceived by college students. Students rate their teachers' four PCK domains. The four domains are described as SMK, the level of teacher understanding of the content taught; IOC, PK along with the understanding of the context for teaching the content

within the classroom environment; KSU, the knowledge of the students' understanding of the content, to include prior knowledge and understandings, and the assessment of that knowledge; and IRS, the teacher's ability to scaffold students' understanding through assimilations, metaphors, analogies, etc. (Jang et al., 2009, Lucenario et al., 2016). The survey instrument consisted of a total of 28 Likert type scaled statements, seven statements for each of the four PCK domains. The Likert type scale reflected a scale of Never (1), Seldom (2), Sometimes (3), and Often (4). Due to the ratio of indicators to latent variables, 7:1, the ATPCK was considered to be overdetermined (Hogarty et al., 2005; MacCallum et al., 1999; Wang & Wang, 2012). Researchers have indicated that high overdetermination reduces the impact of sample size (Hogarty et al., 2005; MacCallum et al., 1999). The measurement tool (Appendix A) utilized by Lucenario et al. (2016) was used for this research. The tool divided the concept of PCK into the four domains (factors) discussed prior and provided seven indicators for each of the four factors (SMK, IOC, KSU, and IRS), as shown in Table 1. Each indicator was measured using the Likert scale discussed.

The measurement instrument was first developed by Jang et al. (2009) through a pilot study consisting of 16 "novice" (p.599) college teachers and 182 students. The original instrument consisted of 15 indicators developed to measure Shulman's (1987) PCK categories of instructional representation, strategies, and assessment of students' prior knowledge (Jang et al., 2009). Each of the three categories (three-factor model) consisted of five indicators (Jang et al., 2009). After data collection and evaluation through exploratory factor analysis, along with researchers' discussions with educators and "five experienced college teachers" (p.599), the published survey instrument

(ATPCK) was developed (Jang et al., 2009). Jang et al.'s (2009) final survey instrument consisted of four-factors, each factor having seven indicators.

The reliability of the ATPCK measure was evaluated using Cronbach's alpha with a value of 0.965, indicating a good internal consistency (Jang et al., 2009; Lucenario et al., 2016). However, scale reliability for each factor was not reported. Jang et al.'s (2009) factor loadings for the seven indicators associated with each of the four-factors were reported as follows: SMK ranged from 0.762 to 0.860, with a total variance explained of 64.515%, IRS ranged from 0.625 to 0.819, percentage of total variance explained was 57.031%, IOC ranged from 0.745 to 0.885, percentage of total variance explained was 67.659%, and KSU ranged from 0.749 to 0.834, percentage of total variance explained was 64.159%. Wang and Wang (2012) stated that to determine communality, factor loadings are squared for each indicator. Therefore, the factor loading values reported by Jang et al. (2009) would indicate a high communality. The indication of high communality was an important factor when considering sample size (Hogarty et al., 2005; MacCallum et al., 1999). Research findings indicated that high communality reduced the impact of sample size (Hogarty et al., 2005; MacCallum et al., 1999). Jang et al. (2009) provided no discussion or results for the evaluation of the goodness of fit for the ATPCK.

For this research study, Lucenario et al.'s (2016) adapted version of the instrument was utilized. Lucenario et al.'s (2016) adaptation changed Jang et al.'s (2009) indicators from first person possessive to third-person neutral. Additionally, the Likert scale went from five options in Jang et al.'s (2009) survey to four options. No purpose for the noted changes was provided in Lucenario et al.'s (2016) discussion of the

measurement tool. Furthermore, Lucenario et al. (2016) did not provide construct validity or reliability confirmation practices utilized to confirm the construct validation and reliability of the measure. Lucenario et al. (2016) reported the factor loadings and Chronbach's alpha values from Jang et al.'s (2009) research to support construct validity and reliability. J.L. Lucenario granted permission to utilize the tool for this research via email received on September 21, 2018, and by S.J. Jang via email received on September 10, 2019. Although the instrument was developed as a student assessment of teachers' PCK, the research-validated the use of the instrument as a teachers' self-assessment of PCK. Therefore, the factors were reworded to reflect the first person for teacher self-assessment: the context of the factors were not modified. Additional demographic questions were added to the instrument, such as GaPSC certified teacher (dichotomous), gender, Title I school (dichotomous), grade level (K-5, 6-8, 9-12), and years of teaching experience.

## Procedures

### Ethical Considerations

Informed consent and informant protection are ethical considerations that must be considered when human participatory research is conducted (Bogdan & Biklen, 2016; Yin, 1994). Principal recruitment letter emails (Appendix B) were sent out to all principals in the identified district requesting Letters of Agreement to participate in the research study. Seventeen Letters of Agreement were received; principals of eight primary/elementary, five middle, and four high schools responded.

Upon Institutional Review Board (IRB) approval, the researcher obtained authorization from the target Title I school district to complete the study. To obtain

authorization from the target research district, a written consent letter from the researcher's supervisor was submitted to the district, along with 17 school level Letters of Agreement to participate in the research and the research proposal. Additionally, the district required a letter stating that anonymity would be maintained throughout the research process and that research results would be shared with the district office upon completion.

Upon receipt of IRB approval and district authorization, the ATPCK survey instrument was shared through the electronic platform, Survey Monkey™. A link to the survey was emailed to 1,054 certified teachers employed by the target district discussed before completion during the Spring semester 2020. Access to teacher email addresses was acquired through each participating school's website staff listing. Potential participants were provided a concise description and purpose for the research, as well as insight into the survey instrument via the educator recruitment email (Appendix C). The email contained a web link to the survey and a direct link created within the Survey Monkey™ platform. The Informed Consent document (Appendix D) was the first component of the survey and included participants' rights, a guarantee of participants' confidentiality and anonymity, foundations for the study, anticipated time requirement, and researcher's contact information. No compensation was provided to participants for completion of the survey. The initial survey question directed the participants to review Informed Consent and then select "I agree" to continue or "I do not agree" to end the survey.

No IP address data were gathered, thus assuring confidentiality. Additionally, to ensure participant anonymity, no participant identity data were published. Any

participant data gathered were maintained on the researcher's password-protected personal computer. Any personal identification data gathered will be deleted six months after completion and acceptance of the final research project. A two-week window for survey response was established. Non-respondents were sent a reminder email one week after the initial survey request had been sent. A single data collection occurred for participating individuals.

## Data Analysis

Confirmatory factor analysis (CFA) was utilized to determine the construct validity and reliability of the ATPCK as a self-assessment measure instrument with 264 survey responses. Construct validation and reliability of the ATPCK self-assessment survey was completed through discriminatory CFA utilizing MPlus 8, Version 1.7 software (Muthén & Muthén, 2012). Wang and Wang (2019) stated that CFA was the basic piece of Structural Equation Modeling (SEM) and that SEM practices can be utilized to evaluate construct validity.

For determination of Cronbach's alpha IBM SPSS Statistics, Version 25 (IBM, 2017) was utilized, and values for Raykov's rho calculations were extrapolated from MPlus 8 (Muthén & Muthén, 2012) CFA results.

Jang et al.'s (2009) proposed a theoretical model (Figure 3) that was evaluated for the goodness of fit before analysis of parameter estimates. Wang and Wang (2019) shared that if a model does not show an acceptable fit, any analysis of results could be incorrect. MPlus 8 (Muthén & Muthén, 2012) results output provided the following common measures of goodness of fit:

Tucker-Lewis index (TLI>0.90); compares the lack of fit between the theoretical model and the null model (Wang & Wang, 2019).

Comparative Fit Index (CFI>0.95); assumes zero covariance amongst factors when comparing the theoretical model to a null model (Wang & Wang, 2019).

Root-mean-square Error of Approximation (RMSEA, 0 = perfect fit, <0.05 close fit, 0.05-0.08 fair fit, 0.08-0.10 mediocre fit, and >0.10 poor fit); measures the lack of fit between the theoretical model and the population. Mplus calculates a 90% confidence interval (CI) for RMSEA and should reflect a 0.05-0.08 value. Additionally, a close fit test of the null hypothesis ($H_0$:RMSEA will be evaluated for a desired $p$>0.05 value (Wang & Wang, 2019).

Standardized-root-mean-square of Residual (SMSR<0.08 good fit, <0.10 acceptable fit); a standardized "residual-based model fit indices" (Wang & Wang, 2019, p. 22). SMSR value tends to decrease with an increase in sample size and number of parameters in the model (Wang & Wang, 2019).

Utilizing the fit indices discussed above, Jang et al.'s (2009) theoretical model (Figure 3) was evaluated for the goodness of fit. Figure 3 provided the theoretical model for the ATPCK survey developed through EFA and validated through CFA (Jang et al., 2009). The figure (Figure 3) represents a four-factor model, with each factor aligning to one of the four PCK domains (SMK-$\xi_1$, IOC-$\xi_2$, KSU-$\xi_3$, IRS-$\xi_4$). Seven indicator variables determined each factor ($\xi_1$: $X_1$-$X_7$, $\xi_2$: $X_8$-$X_{14}$, $\xi_3$: $X_{15}$-$X_{21}$, and $\xi_4$: $X_{22}$-$X_{28}$).

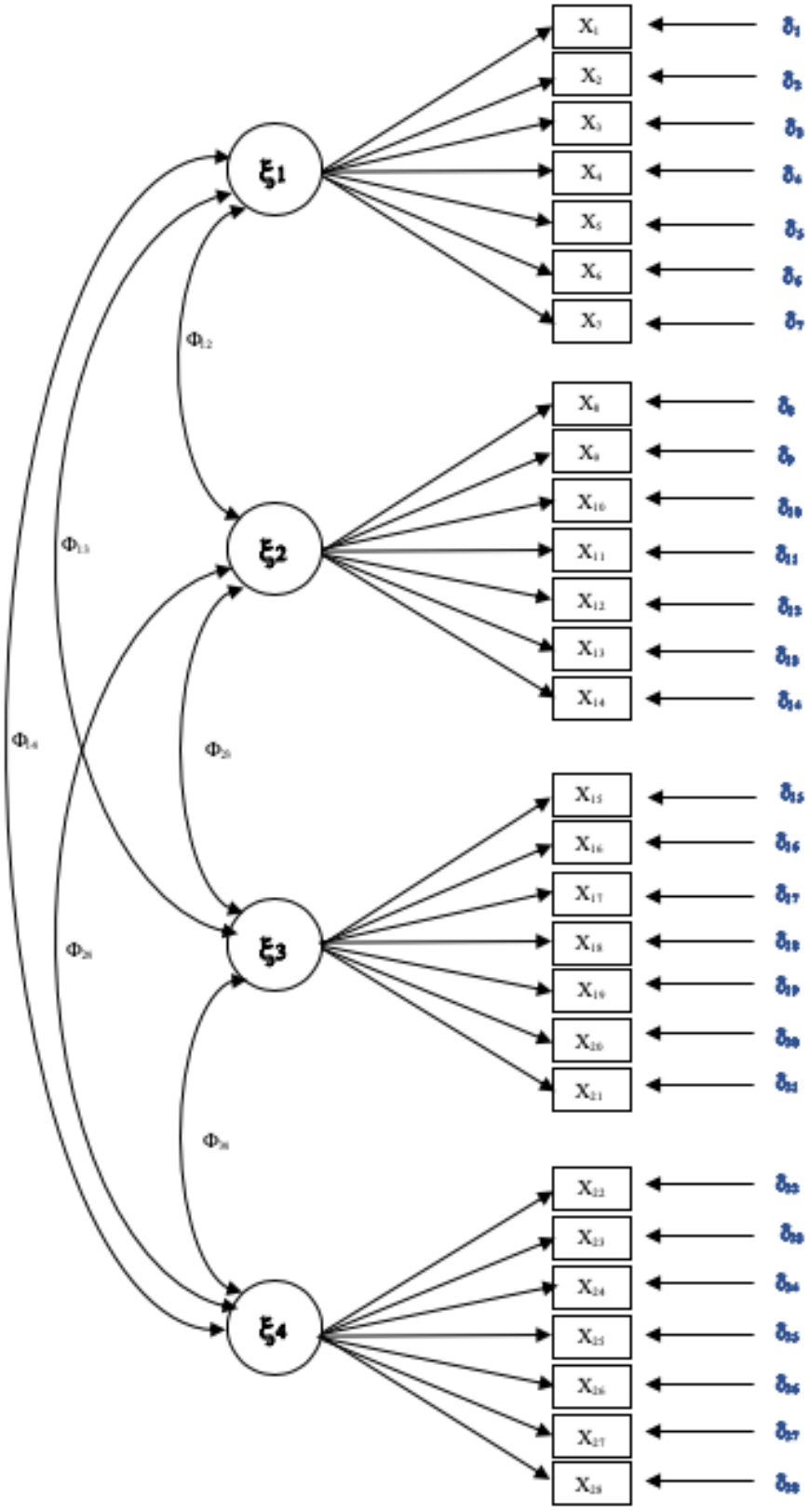


*Figure 3.* Jang et al.'s (2009) theoretical four-factor model analyzed through CFA.

Fit analysis of Jang et al.'s (2009) model (Figure 3) was analyzed utilizing MPlus 8, Version 1.7 (Muthén & Muthén, 2012) CFA practices. Maximum likelihood (ML) was the default estimator in MPlus 8 and assumed the data were continuous and multivariate normal (Wilcox, 2016). Due to the ordinal nature of the data, the weighted least squared means and variances (WLSMV) estimator was utilized (Beauducel & Herzberg, 2006). Beauducel and Herzberg (2006) shared due to the inherent bias of categorical data; the WLSMV estimates compensated more effectively than ML estimates. However, if none of the models reflected good fit, a model specification was utilized to determine the possible causes for lack of fit (Wang & Wang, 2019).

For reliability evaluation of the ATPCK as a self-assessment, Cronbach's alpha, based on the essential tau-equivalent model, was utilized. Unfortunately, coefficient alpha has been acknowledged to "needlessly" underestimate the reliability and was considered a "lower bound estimate" (Graham, 2006, pg. 936). To avoid the potential underestimation of reliability, an essential tau-equivalent hierarchal model was used to determine CFA model reliability (Graham, 2006). Additionally, Raykov's rho calculations were performed utilizing data from the MPlus 8 (Muthén & Muthén, 2012) CFA output and Equation 1 (Wang & Wang, 2012):

$$\rho = \frac{(\sum_i \lambda_i)^2}{(\sum_i \lambda_i)^2 + \sum_i \theta_i} \quad (1)$$

## Summary

Chapter 3 presents the methodology utilized to confirm the internal structure validity and reliability for the ATPCK as a self-assessment measure. The methods employed include a cross-sectional design utilizing confirmatory factor analysis to confirm the validity of the ATPCK as a self-assessment tool for various grade level

teachers: K-12, 6-8, and 9-12. Cronbach's alpha and Raykov's rho were utilized to evaluate the reliability of the ATPCK as a self-assessment, as well as the reliability of the individual scale factors (SMK, IOC, KSU, and IRS). Data and discussion of results have been reported in Chapter 4. Conclusions drawn from the research and implications for future research have been addressed in Chapter 5 of the research dissertation.

# CHAPTER IV

# RESULTS

Establishing an explicit link between teachers' professional knowledge and instructional practices and the impact of teachers' PCK has been elusive in the absence of empirical testing (Aydeniz & Demet 2014; Loewenberg Ball et al., 2008). Therefore, the purpose of this research was to evaluate the construct validity and reliability of the ATPCK for use as a teacher self-assessment to inform professional development practices. Validation of the ATPCK would allow for the use of the measure to inform district professional development practices. The construct validity and reliability of the ATPCK were examined as a self-assessment tool for public K-12 school teachers within a Title I school district. In Chapter 3, the methodology for validation of the Assessment of Teacher's Pedagogical Content Knowledge as a self-assessment was presented. The researcher presented in Chapter 4 the data analysis utilized to address the following research questions:

To what extent will the ATPCK measure, when modified to be used as a teacher self-assessment, show evidence of:

1. A four-factor structure with seven loading indicators per factor as determined by Jang et al. (2009)?
2. Internal consistency reliability?

## Participants

The research target was a public Title I school district located in suburban Atlanta, Georgia. With 58.9% of the student population living below the poverty line, qualifying for free or reduced lunch, or receiving federal assistance. The district consisted of 38 campuses; 23 elementary schools, eight middle schools, five high schools, one alternative school, and one career academy (hcbe.net, 2019). Approximately 69.6% of the elementary schools, 62.5% of middle schools, and 60.0% of high schools were classified as Title 1 schools. The selection of the sample for construct validation and reliability of the ATPCK was chosen utilizing purposive sampling techniques. According to Johnson and Christensen (2017), purposive sampling is a "non-random" sampling practice that allowed the researcher to solicit input from a population with specific traits. The advantages of purposive sampling included ease of access to participants and no-to-low cost of solicitation for participation (Johnson & Christensen, 2017). However, because of the non-random nature of purposive sampling, generalization was limited. For this research, the Georgia Professional Standards Commission (GaPSC) certified teachers in a Title I school district were invited to participate. The researcher was employed by the Title I district, allowing for ease of access to participants.

To obtain self-assessment ratings from GaPSC certified teachers at various grade levels, a non-experimental cross-sectional design was utilized. Johnson and Christensen (2017) stated that the advantage of non-experimental cross-sectional research was the allowance for data collection across multiple group types at one time, or once during a short window of time. Non-experimental research allowed for observational research that

occurred in a natural setting resulting in inferences regarding observed relationships between variables (Johnson & Christensen, 2017). Although the use of this research typology did not allow for the determination of causality, non-experimental research was important in educational research because the manipulation of independent variables could be considered unethical (Johnson and Christensen, 2017).

Participants were given two weeks to complete the survey; those who had not completed the survey during week one were sent a reminder email. There were 276 total responses, and, of those 276, two chose not to accept the informed consent. Additionally, ten respondents were not Georgia PSC (GaPSC) certified teachers; therefore, their responses were not included in the analysis. The final respondents included 264 GaPSC certified teachers from 17 different schools in the identified district; eight primary/elementary, five middle schools, and four high schools. The response rate of certified employees was 23.3% (246 completed surveys of 1054 emailed participants). The participation rate of the total schools in the district was 44.7% (17 of 38); the elementary participation rate was 34.8%, the middle school participation rate was 62.5%, and the high school participation rate was 80.0%. Neither the career academy nor alternative school participated.

The range of response rates for individual questions (indicators) ranged from 239 of 264, 25 missing responses, to 255 of 264, with nine missing responses. Missing data values tended to increase as the respondents progressed through the survey. All missing data were coded as -999 and identified as missing in MPlus 8, Version 1.7 (Muthén & Muthén, 2012), and SPSS Statistics, Version 25 (IBM, 2017) for analysis.

The target value for the sample size to indicator ratio was 10:1 (Everitt, 1975); the achieved participant size to indicator ratio was 9:1. However, due to the empirically determined high communality of the survey indicators, as well as the overdetermination of the latent variables (7:1), the impact of sample size was minimized (Hogarty et al., 2005; MacCallum et al., 1999).

## Findings

Confirmatory factor analysis (CFA) and descriptive statistics were determined employing MPlus 8, Version 1.7 (Muthén & Muthén, 2012), as well as IBM SPSS Statistics, Version 25 (IBM, 2017), to evaluate Jang et al.'s (2009) theoretical model, a four-factor structure with seven loading indicators per factor (Model 1). Additional analysis of four-factor models, with a reduced number of indicators, were also evaluated utilizing CFA and descriptive statistics. The fit indices that were utilized include Chi-square ($\chi 2$), which evaluates the differences between the sample data and the estimated model data (Wang & Wang, 2012). The root means square error of approximation (RMSEA), which measures the models "lack of fit per degrees of freedom" (Wang & Wang, 2012, p. 19); comparative fit index (CFI) measures the "ratio of improvement in noncentrality to the noncentrality of the null model" (Wang & Wang, 2012, p. 18). Tucker-Lewis index (TLI), which compares the proposed model's lack of fit to the null model, was also utilized along with standardized root mean square residual (SRMR), which was the standardized "square root of the average residual" (Wang & Wang, 2012, p. 20). According to Asparauhov and Muthén (2018) and Wang and Wang (2012), the Chi-square fit index is used differently in CFA such that a non-significant outcome was desired ($p>.05$). Asparauhov and Muthén (2018) also stated that the Chi-square statistic

was an exact fit measure. Therefore, if Chi-square results showed non-significance, the SRMR index was not necessary as a fit index but could be used as a tool to evaluate the difference between the estimated model and sample data (Asparauhov & Muthén, 2018). However, Wang and Wang (2012) stated Chi-square has limitations as the index was sensitive to sample size, assumptions of multivariate normality violations, and the number of parameters. Therefore, Chi-square should not be used to rule out a proposed model but used in conjunction with other fit indices (Wang & Wang, 2012). According to Wang, and Wang (2012), the values for each of the fit indices are; RMSEA: 0 = perfect fit; <.05 = close fit; .05-.08 = fair fit; .08-.10 mediocre fit; and >.10 poor fit, CFI and TLI: 0 = worst fit, while 1 = best fit; value for good fit = .90 to .95 and SRMR values less than .10 are "acceptable." Asparauhov and Muthén (2018) shared that SRMR was sensitive to sample size, with a target sample size larger than 200.

Confirmatory factor analysis was run through MPlus 8 (Muthén & Muthén, 2012) utilizing the weighted least mean squared variance-adjusted (WLSMV) estimator due to the ordinal nature of the data. The WLSMV was one of the multiple robust estimators available through MPlus 8 (Muthén & Muthén, 2012). The robust nature of the WLSMV estimator minimized the effects of outliers (Flora, Labrish, & Chalmers, 2012; Wang & Wang, 2012), thereby, allowing for all missing data to be coded as -999 and identified in both Mplus 8 (Muthén & Muthén, 2012) and SPSS Statistics (IBM, 2017) as discrete "missing" data for analysis.

Cronbach's alpha, a measure of internal consistency reliability, was determined to utilize SPSS Statistics, Version 25 software (IBM, 2017). Cronbach's alpha measured the correlations between the indicators that make up the scale. According to Muijs

(2011), a Cronbach's alpha value greater than .70 was acceptable for "research purposes." However, Wang and Wang (2012) stated that due to measurement parameters, Cronbach's alpha might reflect an underestimated, or even overestimated scale reliability. Therefore, additional reliability values were determined to utilize Raykov's Rho (Arifin, 2019; Wang & Wang, 2012). Arifin (2019) stated, "construct reliability $\geq$.70 is acceptable" (p. 14). The Raykov's rho equation (Eq. 1) utilized was:

$$\rho = \frac{(\sum_i \lambda_i)^2}{(\sum_i \lambda_i)^2 + \sum_i \theta_i} \quad (1)$$

Model 1

Frequency data for indicator variables (Table 3) was evaluated and indicated that the Likert scale item "never" was not selected for 24 of the 28 indicators, two indicators (SMK1 and IOC7) showed 0.4% selection frequency and two indicators (KSU7 and IRS7) showed 0.8% selection frequency. Furthermore, descriptive statistics (Table 3) indicated mean values 3.536 through 3.984 for the 28 indicators; "never" was assigned a value of one, "seldom" was assigned a value of two, "sometimes" was assigned a value of three and "often" was assigned a value of four for analysis. Therefore, the data were collapsed such that the Likert scale items "never" and "seldom" were merged. All additional data analysis, beyond Jang et al.'s (2009) theoretical model, was performed on collapsed data.

Table 3

Frequency and Descriptive Statistics Data for Valid and Missing Responses by Latent Factor for Seven Indicators per Factor

| Responses | SMK1 | | SMK2 | | SMK3 | | SMK4 | | SMK5 | | SMK6 | | SMK7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent |
| Never | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 |
| Seldom | 1 | .400 | 0 | .000 | 9 | 3.400 | 2 | .800 | 0 | .000 | 11 | 4.200 | 1 | .400 |
| Sometimes | 1 | .400 | 5 | 1.900 | 69 | 26.100 | 20 | 7.600 | 20 | 7.600 | 76 | 28.800 | 53 | 20.100 |
| Often | 252 | 95.500 | 250 | 94.700 | 177 | 67.000 | 233 | 88.300 | 233 | 88.300 | 167 | 63.300 | 201 | 76.100 |
| Missing | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 |
| *N* | 254 | | 255 | | 255 | | 255 | | 253 | | 254 | | 255 | |
| Mean | 3.984 | | 3.980 | | 3.659 | | 3.906 | | 3.921 | | 3.614 | | 3.784 | |
| Std Dev | .198 | | .139 | | .545 | | .318 | | .270 | | .570 | | .422 | |

| Responses | IOC1 | | IOC2 | | IOC3 | | IOC4 | | IOC5 | | IOC6 | | IOC7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent |
| Never | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 1 | .400 |
| Seldom | 1 | .400 | 0 | .000 | 0 | .000 | 2 | .800 | 4 | 1.500 | 0 | .000 | 3 | 1.100 |
| Sometimes | 23 | 8.700 | 11 | 4.200 | 16 | 6.100 | 23 | 8.700 | 61 | 23.100 | 29 | 11.000 | 56 | 21.200 |
| Often | 226 | 85.600 | 239 | 90.500 | 234 | 88.600 | 225 | 85.200 | 182 | 68.900 | 221 | 83.700 | 189 | 71.600 |
| Missing | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 |
| *N* | 250 | 94.700 | 250 | 94.700 | 250 | 94.700 | 250 | 94.700 | 247 | 93.600 | 250 | 94.700 | 249 | 94.300 |
| Mean | 3.900 | | 3.956 | | 3.936 | | 3.892 | | 3.721 | | 3.884 | | 3.739 | |
| Std Dev | .314 | | .206 | | .245 | | .336 | | .484 | | .321 | | .492 | |

(*Continues*)

Table 3 (*Continued*)

*Frequency and Descriptive Statistics Data for Valid and Missing Responses by Latent Factor for Seven Indicators per Factor*

| | KSU1 | | KSU2 | | KSU3 | | KSU4 | | KSU5 | | KSU6 | | KSU7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Responses | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent |
| Never | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 2 | .800 |
| Seldom | 5 | 1.900 | 6 | 2.300 | 1 | .400 | 1 | .400 | 0 | .000 | 1 | .400 | 1 | .400 |
| Sometimes | 105 | 39.800 | 90 | 34.100 | 33 | 12.500 | 14 | 5.300 | 25 | 9.500 | 18 | 6.800 | 54 | 20.500 |
| Often | 138 | 52.300 | 152 | 57.600 | 214 | 81.100 | 232 | 87.900 | 221 | 83.700 | 227 | 86.000 | 191 | 72.300 |
| Missing | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 |
| *N* | 248 | 93.900 | 248 | 93.900 | 248 | 93.900 | 247 | 93.600 | 246 | 93.200 | 246 | 93.200 | 248 | 93.900 |
| Mean | 3.536 | | 3.589 | | 3.859 | | 3.935 | | 3.898 | | 3.919 | | 3.750 | |
| Std Dev | .539 | | .540 | | .360 | | .263 | | .303 | | .288 | | .495 | |

| | IRS1 | | IRS2 | | IRS3 | | IRS4 | | IRS5 | | IRS6 | | IRS7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Responses | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent | Freq. | Percent |
| Never | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 0 | .000 | 2 | .800 |
| Seldom | 0 | .000 | 2 | .800 | 2 | .800 | 5 | 1.900 | 1 | .400 | 0 | .000 | 8 | 3.000 |
| Sometimes | 14 | 5.300 | 49 | 18.600 | 81 | 30.700 | 54 | 20.500 | 54 | 20.500 | 45 | 17.000 | 44 | 16.700 |
| Often | 226 | 85.600 | 189 | 71.600 | 157 | 59.500 | 180 | 68.200 | 184 | 69.700 | 195 | 73.900 | 186 | 70.500 |
| Missing | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 | 9 | 3.400 |
| *N* | 240 | 90.900 | 240 | 90.900 | 240 | 90.900 | 239 | 90.500 | 239 | 90.500 | 240 | 90.900 | 240 | 90.900 |
| Mean | 3.942 | | 3.779 | | 3.646 | | 3.732 | | 3.766 | | 3.813 | | 3.725 | |
| Std Dev | .235 | | .435 | | 0.496 | | .489 | | .434 | | .391 | | .563 | |

Analysis of correlation data (Table 4) demonstrated that the indicator subject matter knowledge indicator one (SMK1) showed a high rate of negative correlation, 11 of 28 indicators were less than or equal to -.986. Additionally, SMK2 showed a high rate of negative correlation, ten of the 28 indicators, with one indicator equal to -.986. Evaluation of the context of the indicators SMK1 and SMK2 also were considered because both indicators had multiple negative correlation values (Table 4). SMK1 stated, "The teacher knows the content he/she is teaching." Whereas indicator SMK2 stated, "The teacher explains clearly the content of the subject." Both items evaluated "content of subject"; however, SMK1 was written in the passive voice and was subjective, whereas SMK2 was written in active voice and was objective. Additional analysis of the remaining indicators for SMK reflects an implicit knowledge of "content of subject" is required for appropriate responses to the remaining indicators. For example, indicator SMK4, "[T]he teacher selects the appropriate content for students," implies that the teacher's content knowledge allows for the discernment as to what content knowledge is appropriate for student growth. Therefore, based on the high rate of negative correlations and the value of the correlations, as well as the context of the statement and remaining statements, indicator SMK1 was removed from analysis beyond Jang et al.'s (2009) theoretical model. The removal of the indicator was justified as the latent factors are overidentified; "observed pieces of information are more than model parameters that need to be estimated" (Wang & Wang, 2012, p. 5), each factor having seven indicators.

Table 4
*Correlation Table for Four-Factor Structure with Seven Loading Indicators per Factor by Factor*

| Indicators | SMK1 | SMK2 | SMK3 | SMK4 | SMK5 | SMK6 | SMK7 |
|---|---|---|---|---|---|---|---|
| SMK1 | 1.000 | | | | | | |
| SMK2 | 1.000 | 1.000 | | | | | |
| SMK3 | .491 | .394 | 1.000 | | | | |
| SMK4 | .929 | .841 | .415 | 1.000 | | | |
| SMK5 | -.987 | .254 | .227 | .010 | 1.000 | | |
| SMK6 | -.986 | -.073 | .422 | .031 | .400 | 1.000 | |
| SMK7 | .147 | .339 | .692 | .295 | .421 | .450 | 1.000 |
| IOC1 | -.986 | .026 | .200 | -.088 | .160 | .367 | .538 |
| IOC2 | -.987 | -.002 | .204 | .100 | .069 | .155 | .396 |
| IOC3 | .442 | .397 | .276 | .264 | .314 | .149 | .339 |
| IOC4 | .211 | .077 | .231 | .071 | -.102 | .388 | .203 |
| IOC5 | -.986 | -.986 | .165 | .205 | .004 | .050 | .264 |
| IOC6 | -.986 | .009 | .367 | .266 | -.006 | .274 | .501 |
| IOC7 | -.986 | -.062 | .041 | -.005 | .026 | .242 | .247 |
| KSU1 | -.986 | -.185 | .075 | .059 | .404 | .129 | .253 |
| KSU2 | .067 | .192 | .179 | .166 | .257 | .153 | .122 |
| KSU3 | -.044 | .147 | .129 | .169 | .176 | .036 | .259 |
| KSU4 | .232 | .247 | .126 | .181 | .372 | -.074 | .483 |
| KSU5 | .418 | .262 | .298 | .338 | .175 | .324 | .114 |
| KSU6 | .461 | .525 | .049 | .333 | .219 | -.014 | .211 |
| KSU7 | -.174 | .098 | .371 | .025 | .213 | .279 | .284 |
| IRS1 | -.987 | .307 | .051 | .169 | .336 | .169 | .271 |
| IRS2 | -.986 | -.051 | .246 | .015 | .154 | .267 | .084 |
| IRS3 | -.322 | -.083 | .266 | .027 | .167 | .234 | .205 |
| IRS4 | -.046 | -.082 | .217 | .033 | .286 | .379 | .208 |
| IRS5 | -.986 | -.306 | .237 | -.007 | .221 | .225 | .353 |
| IRS6 | -.121 | -.104 | .237 | .030 | .100 | .272 | .238 |
| IRS7 | -.019 | .025 | -.004 | -.095 | .082 | .014 | -.012 |

(*Continues*)

Table 4 (*Continued*)
*Correlation Table for Four-Factor Structure with Seven Loading Indicators per Factor by Factor*

| Indicators | IOC1 | IOC2 | IOC3 | IOC4 | IOC5 | IOC6 | IOC7 |
|---|---|---|---|---|---|---|---|
| IOC1 | 1.000 | | | | | | |
| IOC2 | .859 | 1.000 | | | | | |
| IOC3 | .641 | .719 | 1.000 | | | | |
| IOC4 | .559 | .682 | .632 | 1.000 | | | |
| IOC5 | .194 | .334 | .166 | .263 | 1.000 | | |
| IOC6 | .468 | .697 | .151 | .264 | .459 | 1.000 | |
| IOC7 | .214 | .264 | .373 | .253 | .428 | .364 | 1.000 |
| KSU1 | .104 | .155 | .222 | .141 | .245 | .221 | .191 |
| KSU2 | .046 | -.268 | .243 | -.179 | .191 | -.144 | .055 |
| KSU3 | .592 | .643 | .613 | .516 | .215 | .179 | .140 |
| KSU4 | .497 | .533 | .433 | .333 | .036 | .189 | .056 |
| KSU5 | .183 | .397 | .588 | .478 | .161 | .209 | .212 |
| KSU6 | .333 | .427 | .345 | .189 | .222 | .330 | -.060 |
| KSU7 | .374 | .230 | .257 | .375 | .070 | .132 | .239 |
| IRS1 | .522 | .401 | .285 | -.037 | .073 | .299 | .134 |
| IRS2 | .384 | .227 | .089 | .205 | .093 | .098 | -.049 |
| IRS3 | .381 | .193 | .312 | .406 | .305 | .271 | .180 |
| IRS4 | .414 | .296 | .366 | .333 | .140 | .229 | .021 |
| IRS5 | .325 | .259 | .357 | .270 | .257 | .144 | .190 |
| IRS6 | .323 | .467 | .456 | .566 | .301 | .282 | .118 |
| IRS7 | .096 | .136 | .097 | .055 | .126 | .168 | -.172 |

(*Continues*)

Table 4 (*Continued*)
*Correlation Table for Four-Factor Structure with Seven Loading Indicators per Factor by Factor*

| Indicators | KSU1 | KSU2 | KSU3 | KSU4 | KSU5 | KSU6 | KSU7 |
|---|---|---|---|---|---|---|---|
| KSU1 | 1.000 | | | | | | |
| KSU2 | .710 | 1.000 | | | | | |
| KSU3 | .419 | .322 | 1.000 | | | | |
| KSU4 | .458 | .399 | .753 | 1.000 | | | |
| KSU5 | .158 | .248 | .476 | .259 | 1.000 | | |
| KSU6 | .425 | -.032 | .736 | .563 | .411 | 1.000 | |
| KSU7 | .185 | .212 | .494 | .284 | .388 | .514 | 1.000 |
| IRS1 | .351 | .243 | .506 | .145 | .152 | .417 | .385 |
| IRS2 | .239 | .236 | .410 | -.021 | .164 | .244 | .401 |
| IRS3 | .233 | .224 | .563 | .439 | .225 | .388 | .629 |
| IRS4 | .249 | .120 | .466 | .300 | .386 | .265 | .294 |
| IRS5 | .253 | .298 | .422 | .304 | .205 | .138 | .247 |
| IRS6 | .152 | .138 | .619 | .406 | .384 | .337 | .338 |
| IRS7 | .029 | .010 | .150 | -.019 | .169 | .298 | .048 |

| Indicators | IRS1 | IRS2 | IRS3 | IRS4 | IRS5 | IRS6 | IRS7 |
|---|---|---|---|---|---|---|---|
| IRS1 | 1.000 | | | | | | |
| IRS2 | .821 | 1.000 | | | | | |
| IRS3 | .467 | .419 | 1.000 | | | | |
| IRS4 | .636 | .537 | .446 | 1.000 | | | |
| IRS5 | .374 | .382 | .439 | .513 | 1.000 | | |
| IRS6 | .126 | .190 | .369 | .418 | .492 | 1.000 | |
| IRS7 | .276 | .228 | .184 | .271 | .328 | .371 | 1.000 |

To address research question one, "To what extent will the ATPCK measure, when modified for use as a teacher self-assessment, show evidence of a four-factor structure with seven loading indicators per factor as determined by Jang et al. (2009)?" CFA was conducted utilizing MPlus 8 software (Muthén & Muthén, 2012). Jang et al.'s (2009) theoretical model, four-factor, seven loading indicators each, did not exhibit a good fit. The fit indices data (Table 5) for the theoretical model were $\chi 2_{(344)} = 974.128$, $p = .000$, RMSEA = .089, CFI = .729, TLI = .702 and SRMR = .205 suggesting that Jang et al.'s (2009) theoretical ATPCK measure was not an appropriate measure for teacher self-assessment. However, the overidentification (Wang & Wang, 2012) of the factors allowed for a "model specification search" (p. 23) to determine a potential theoretical model that could be utilized as a teacher self-assessment measure to inform professional development practices.

Table 5

*Fit Index Statistics for Four-Factor Latent Variable Model with Indicators Removed as Noted*

| Fit Statistics | $\chi 2$ | *df* | *p* | RMSEA | CFI | TLI | SRMR |
|---|---|---|---|---|---|---|---|
| Model 1 28 indicators | 974.128 | 344. | .000 | .089 | .729 | .702 | .205 |
| Model 1a* 27 indicators | 490.972 | 318. | .000 | .046 | .889 | .878 | .143 |
| Model 1b* 26 indicators | 421.883 | 293. | .000 | .042 | .914 | .905 | .132 |
| Model 1c* 24 indicators | 369.695 | 246. | .000 | .045 | .919 | .909 | .132 |
| Model 1d* 22 indicators | 242.623 | 203. | .030 | .028 | .973 | .969 | .104 |

*Note:* *Models 1a through 1d values are based on collapsed data.

Internal consistency reliability evaluation was performed through SPSS Statistics (IBM, 2017). These findings indicated that research question two, "To what extent will the

ATPCK measure, when modified for use as a teacher self-assessment, show evidence of internal consistency reliability?" was supported by the Cronbach's alpha value = .815 for the overall model. However, for the individual factor scales Cronbach's alpha for SMK = .560, for IOC = .552, for KSU = .671 and IRS = .665, did not show an acceptable level of internal consistency reliability for each scale. Additional consistency evaluation with Raykov's rho was not performed due to lack of residual data as a result of the following MPlus 8 (Muthén & Muthén, 2012) output warning statement:

> The residual covariance matrix (theta) is not positive definite. This could indicate a negative variance/residual variance for an observed variable, a correlation greater or equal to one between two observed variables, or a linear dependency among more than two observed variables. Check the results section for more information problems involving variable SMK1.

This warning statement further supported the removal of the SMK1 indicator from further analysis.

Due to the inability to support the research questions proposed, additional CFA was performed through the removal of indicator variables. Overidentification (Wang & Wang, 2012) of the four factors allowed for the removal of indicators. To determine which indicators were removed from the analysis, correlation data (Table 4) for the indicators were reviewed, as well as the MPlus 8 (Muthén & Muthén, 2012) warning statement was considered. This practice was utilized to identify a potential theoretical model that could be utilized as a teacher self-assessment measure to inform professional development practices.

Model 1a

Upon removal of SMK1 and the collapse of Likert scale responses, descriptive statistics were reevaluated (Table 6) and fit analyses were performed. Additional analysis showed that fit indices data (Table 5) did not exhibit good fit but did show improvement; $\chi 2_{(318)} = 490.972$, $p = .000$, RMSEA = .046, CFI = .889, TLI = .878 and SRMR = .143. Internal consistency reliability for the four-factor model was supported for this model with a Cronbach's alpha = .819. However, Cronbach's alpha internal consistency reliability for the individual indicator scales were not supported based on the following Cronbach's alpha values: SMK = .582, IOC = .557, KSU = .669, and IRS = .673. Additional consistency evaluation using Raykov's rho was performed with an overall model consistency of .953 and scale consistency of SMK = .768, IOC = .824, KSU = .887 and IRS = .838. All Raykov's rho values indicated acceptable model and scale consistency.

Table 6
*Descriptive Statistics for Collapsed Data*

| Measured Indicator | Mean | Std. Deviation | *N* |
|---|---|---|---|
| SMK1 | 2.988 | .14 | 254 |
| SMK2 | 2.98 | .139 | 255 |
| SMK3 | 2.659 | .545 | 255 |
| SMK4 | 2.906 | .318 | 255 |
| SMK5 | 2.921 | .27 | 253 |
| SMK6 | 2.614 | .57 | 254 |
| SMK7 | 2.784 | .422 | 255 |
| IOC1 | 2.9 | .314 | 250 |
| IOC2 | 2.956 | .206 | 250 |
| IOC3 | 2.936 | .245 | 250 |
| IOC4 | 2.892 | .336 | 250 |
| IOC5 | 2.721 | .484 | 247 |
| IOC6 | 2.884 | .321 | 250 |
| IOC7 | 2.743 | .473 | 249 |
| KSU1 | 2.536 | .539 | 248 |
| KSU2 | 2.589 | .54 | 248 |
| KSU3 | 2.859 | .36 | 248 |
| KSU4 | 2.935 | .263 | 247 |
| KSU5 | 2.898 | .303 | 246 |
| KSU6 | 2.919 | .288 | 246 |
| KSU7 | 2.758 | .457 | 248 |
| IRS1 | 2.942 | .235 | 240 |
| IRS2 | 2.779 | .435 | 240 |
| IRS3 | 2.646 | .496 | 240 |
| IRS4 | 2.732 | .489 | 239 |
| IRS5 | 2.766 | .434 | 239 |
| IRS6 | 2.813 | .391 | 240 |
| IRS7 | 2.733 | .529 | 240 |

Analysis of correlation matrixes data (Table 7) identified that instructional objective and context indicator five (IOC5), “The teacher prepares some additional teaching materials,” modeled low correlation. The correlation values determined included 18 correlation values less than .300; seven correlation values less than .400 and

one correlation value greater than .400. Additionally, the context of the indicator statement was evaluated. As IOC3, "[T]he teacher…adjust his/her teaching" implies that the teacher has prepared for changes in instructional practices, to include preparation of additional resources, the removal of indicator IOC5 would not impact the intent of the measures for the latent variable, IOC. Therefore, IOC5 was removed from further analysis.

Table 7

*Correlation Values for Instructional Objective and Context Indicator Five (IOC5)*

| Measured Indicator | Correlation with IOC5 |
|---|---|
| SMK2 | -.986 |
| SMK3 | .153 |
| SMK4 | .335 |
| SMK5 | .029 |
| SMK6 | .082 |
| SMK7 | .273 |
| IOC1 | .229 |
| IOC2 | .321 |
| IOC3 | .235 |
| IOC4 | .244 |
| IOC5 | 1.000 |
| IOC6 | .399 |
| IOC7 | .418 |
| KSU1 | .202 |
| KSU2 | .145 |
| KSU3 | .296 |
| KSU4 | .211 |
| KSU5 | .214 |
| KSU6 | .357 |
| KSU7 | .098 |
| IRS1 | .245 |
| IRS2 | .059 |
| IRS3 | .326 |
| IRS4 | .245 |
| IRS5 | .315 |
| IRS6 | .380 |
| IRS7 | .272 |

Model 1b

Once indicators SMK1 and IOC5 were removed from the four-factor model, fit indices indicated an improvement, but not a good fit; $\chi 2_{(293)} = 421.883$, $p = .000$, RMSEA = .044, CFI = .904, TLI = .894 and SRMR = .137. However, internal consistency reliability was supported for the overall model with a Cronbach's alpha = .815. Removal of IOC5 resulted in a Cronbach's alpha value for IOC = .511, a decrease in value, not supporting internal consistency reliability for the scale. Additional scale Cronbach's alpha values for SMK, KSU, and IRS were unchanged from the previous model (1a). Additional consistency evaluation using Raykov's rho was performed with an overall model consistency of .941, which indicated a reduction in overall model consistency. Raykov's rho scale consistency for SMK = .789, IOC = .821, KSU = .887 and IRS = .838; an improvement for SMK, a reduction for IOC, and unchanged for KSU and IRS. All of Raykov's rho values indicated an acceptable model and scale consistency. Therefore, additional analysis of indicator correlations was considered to improve model fit. Analysis of the correlation matrix without indicators SMK1 and IOC5 showed indicators IOC7, "The teacher's belief or value of teaching is active and aggressive," and IRS7 (Table 8), "The teacher uses multimedia or technology (e.g., PowerPoint) to express the concept of the subject," exhibit consistent low correlations with the remaining indicators. Indicator IOC7 had two correlation values greater than .300, while indicator IRS7 had four correlation values equal to or greater than .300. The context of indicators IOC7 and IRS7 were additionally evaluated. IOC7 "belief or value of teaching is active and aggressive" was subjective, as well as "active and aggressive" teaching are vague descriptors. The context of the remaining indicators was also

evaluated to determine the potential impact of removing IOC7. IOC3 states, "[T]he teacher…adjusts his/her teaching," and IOC4 states, "[T]he teacher creates a classroom circumstance to promote my interest for learning" both of these remaining indicators imply active and responsive teaching practices similar to the context of indicator IOC7. Therefore, the removal of IOC7 would not impact the intent of the measures for the latent variable IOC.

Additionally, IRS7 was determined to reflect a superficial description of the use of multimedia or technology in the current technology-rich educational environment.

Further analysis of the remaining indicators determined that indicators IRS3, "[T]he teacher's teaching methods keep me interested in this subject" could imply the use of technology, as well as indicator IRS6, "[T]he teacher uses a variety of teaching approaches…" could imply the use of technology. Hence, the removal of IRS7 would not impact the intent of the measures for the latent variable IRS. Therefore, indicators IOC7 and IRS7 were removed, along with SMK1 and IOC5, for further analysis.

Table 8

*Correlation Values for Instructional Objective and Context IOC7 and Instructional Representation and Strategies IRS7*

| Measured Indicator | IOC7 | IRS7 |
|---|---|---|
| SMK2 | .341 | -.076 |
| SMK3 | .121 | .056 |
| SMK4 | .190 | .106 |
| SMK5 | .002 | .142 |
| SMK6 | .248 | .122 |
| SMK7 | .256 | .006 |
| IOC1 | .139 | .277 |
| IOC2 | .212 | .185 |
| IOC3 | .481 | .192 |
| IOC4 | .232 | .180 |
| IOC6 | .182 | .220 |
| IOC7 | 1.000 | -.304 |
| KSU1 | .179 | .077 |
| KSU2 | .065 | .128 |
| KSU3 | .151 | -.042 |
| KSU4 | .100 | -.034 |
| KSU5 | .196 | .309 |
| KSU6 | -.188 | .099 |
| KSU7 | .191 | .011 |
| IRS1 | .146 | .090 |
| IRS2 | -.047 | .316 |
| IRS3 | .220 | .300 |
| IRS4 | .062 | .285 |
| IRS5 | .241 | .400 |
| IRS6 | .153 | .261 |
| IRS7 | -.304 | 1.000 |

Model 1c

The next model evaluated was a four-factor model with 24 indicators; four indicators were removed from Jang et al.'s (2009) theoretical model, one from the variable SMK, two from IOC, and one from IRS. Analysis indicated model fit indices, $\chi 2_{(246)} = 369.695$, $p = .000$, RMSEA = .045 with a 90% confidence index (CI) between .035 and .054, CFI = .919, TLI = .909 and SRMR = .132, the model was determined to have an acceptable fit, but not good fit. Additionally, the loading factors for the remaining indicators in Model 1c, with standardized XY and standard errors, were presented in Figure 4. The loading factor values for SMK ranged from .436 to .932; for IOC, they ranged from .555 to .848, for KSU, they ranged from .484 to .940, and for IRS they ranged from .594 to .816; all factor loadings were statistically significant with $p <$ .05. According to Wang and Wang (2012), standardized factor loading values exceeding .40 and statistically significant indicated an acceptable indicator measure of the latent variable. For the four-factor, 24 indicator model, Cronbach's alpha = .822 indicated internal consistency reliability for the overall model. However, when evaluating the individual scale Cronbach's alpha internal consistency reliability values, SMK = .582, IOC = .543, KSU = .669, and IRS = .669 remained unsupported within individual scales. Additional consistency evaluation using Raykov's rho was performed with an overall model consistency of .903, which indicated a reduction in overall model consistency from Model 1b. Raykov's rho scale consistency values were determined as follows, SMK = .779, IOC = .619, KSU = .674 and IRS = .699; all Raykov's rho consistency values decreased, with only SMK demonstrating consistency. Consistency results, both

Cronbach's alpha and Raykov's rho indicated a need for additional "model specification search" (Wang & Wang, 2012, p. 23).

For closer evaluation, modification indices (MI) were analyzed utilizing MPlus 8 (Muthén & Muthén, 2012). MI analysis helped to identify potential sources resulting in a reduced fit of the theoretical or hypothesized models (Wang & Wang, 2012). Based on MI recommendations, negative and low correlation values, the lowest loading factor for the SMK factor (.436), was considered for removal from the model for further analysis. Additionally, the context of the indicator statement was evaluated. SMK2 stated, "The teacher explains clearly the content of the subject." Because the ATPCK was validated as a self-assessment rather than a student assessment of teachers' PCK, the frame of reference for the SMK2 statement "content of the subject" may be different from Jang et al.'s (2009) original intent.

Additionally, analysis of the remaining indicators for SMK reflects an implicit knowledge of "content of subject" is required for appropriate responses to the remaining indicators. For example, indicator SMK3, "[T]he teacher knows how theories or principles of the subject have been developed" implies that the depth of the teacher's content knowledge goes beyond basic "content of knowledge." Hence, the removal of SMK2 would not impact the intent of the measures for the latent variable SMK.

Modification indices also identified KSU2, "The teacher knows students' learning difficulties of subject before class" as an additional indicator to evaluate for removal from the theoretical model. When evaluating the vernacular of KSU2, the phrase "learning difficulties" could be considered to be learning difficulties based on cultural bias or identified learning disabilities. Again, the frame of reference from the use of this

research as a self-assessment measure versus a student assessment of teachers' PCK, could change the perception of the statement's intent. Further analysis of the remaining indicators for KSU reflects an implied need for prior knowledge of students' knowledge and learning needs. Indicators KSU3, [T]he teacher questions evaluate my understanding of a topic," and KSU6, "[T]he teacher's assignments facilitate my understanding of the subject" imply the need for prior knowledge of students' "learning difficulties" to ensure students' learning needs are supported and evaluated in the teaching context. Hence, the removal of KSU2 would not impact the intent of the measures for the latent variable KSU. Therefore, the statement was further considered for removal from the model. Furthermore, consideration of correlation values (lowest of all KSU indicators) and loading factor value (.484) indicated a need for removal of the indicator to improve model fit. Based on negative and low correlation values, low loading factor values, MI recommendations, and frame of reference concerns with the statements, indicators SMK2 and KSU2 were removed from the model for additional analysis.

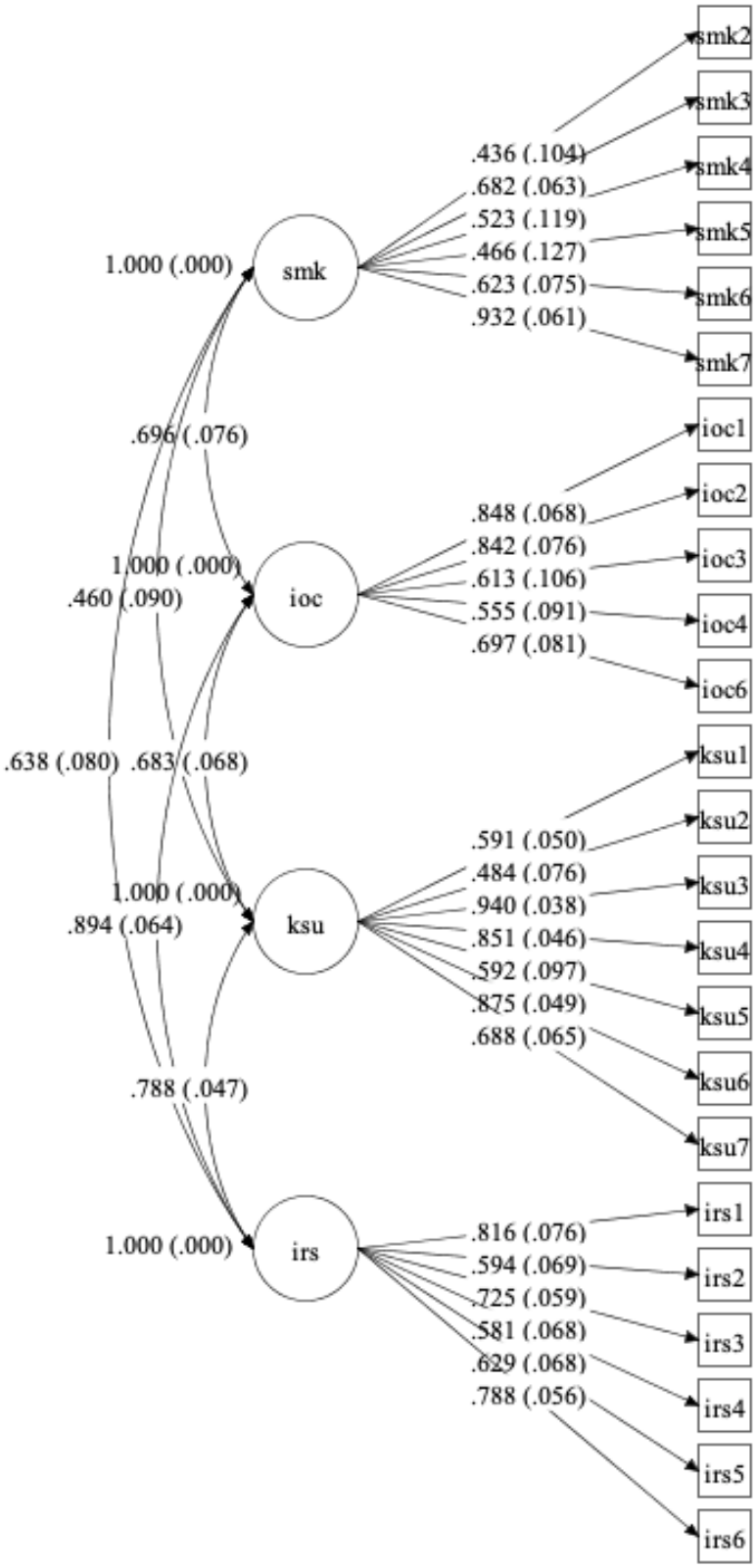


*Figure 4.* Four-factor, 24 indicator confirmatory factor analysis Model 1c. Standardized XY factor loading values and errors.

Model 1d

After consideration of the modification indices (MI) evaluation, the final four-factor model evaluated consisted of 22 indicator variables; five SMK, five IOC, six KSU, and six IRS indicator variable. Evaluation of the model fit indices (Table 5) indicated a model that exhibited good fit; $\chi 2_{(203)} = 242.623$, $p = .030$, RMSEA = .028, with a 90% CI upper limit of .040, CFI = .973, TLI = .969 and SRMR = .104. Although Wang and Wang (2012) stated that SRMR values less than .10 are acceptable, Asparouhov and Muthén (2018) stated if the Chi-square was significant ($p<.05$) and the SRMR value was high, variance residuals should be evaluated for large values. Based on Wang and Wang (2012), a large residual value would exceed a value of 2.58. None of the 22 indicators in the proposed four-factor, 22 indicator model, exceed 2.58; the residual values ranged from SMK5 = .799 through KSU3 = .114. Additional evaluation of the loading factors (Figure 5) indicated loading ranged for SMK from .449 to .920, for IOC loadings ranged from .591 to .848, for KSU loadings ranged from .484 to .940 and for IRS loadings ranged from .581 to .816; all loading factors exhibited $p<.05$. According to Wang and Wang (2012), standardized factor loading values exceeding .40 and statistically significant indicated an acceptable indicator measure of the latent variable.

Reliability evaluation was performed, and the four-factor, 22 indicator model showed a Cronbach's alpha of .817, supporting internal consistency reliability for the overall model. For the individual factor scales Cronbach's alpha values were SMK = .584, IOC = .543, KSU = .666 and IRS = .669. However, Raykov's rho showed an increase in all consistency values over Model 1c. Raykov's rho for the overall model was determined to be .956, with the following scale consistency values; SMK = .780, IOC =

.842, KSU = .891 and IOC = .846. All Raykov's rho consistency values indicated good consistency of a four-factor, 22 indicator model.

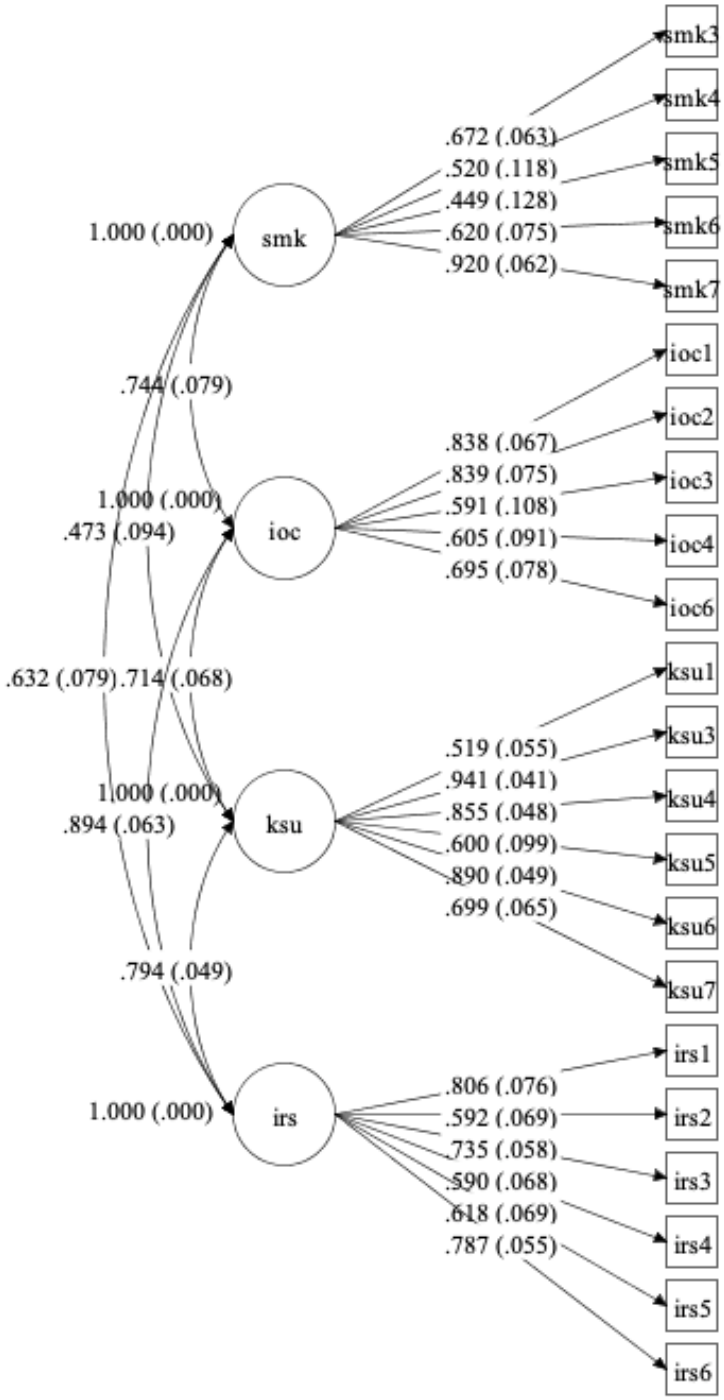


*Figure 5.* Four-factor, 22 indicator confirmatory factor analysis Model 1d. Standardized XY factor loading values and errors.

## Summary

The four-factor, seven loading indicators per factor theoretical model, as determined by Jang et al. (2009) and utilized by Lucenario et al. (2016), was not supported as a teacher self-assessment measure through CFA. Through a "model specification search" (Wang & Wang, 2012, p. 23), evaluation of correlation matrices resulted in six indicators being removed systematically, with a maximum of two and a minimum of one indicator being removed from any factor. As the theoretically proposed model was identified as overestimated, the removal of indicators did not impact the CFA practices (Wang & Wang, 2012). Each consecutively evaluated model indicated improvement in model fit indices (Table 5). The final model identified through a CFA model specification search resulted in a four-factor model: SMK, retaining five indicators; IOC, with five indicators; KSU, retaining six indicators; and IRS retaining six indicators. The final four-factor, 22 indicator model demonstrated good fit (Table 5) with statistically significant factor loadings (Figure 5). Although the SRMR value of .104 was greater than the target .10 (Wang & Wang, 2012), Asparouhov and Muthén (2018) stated that if the Chi-square was significant ($p<.05$) and the SRMR value was high, variance residuals should be evaluated for large values. Based on Wang and Wang (2012), a large residual value would exceed a value of 2.58. None of the 22 indicators in the proposed four-factor, 22 indicator model, exceed 2.58; the residual values ranged from SMK5 = .799 through KSU3 = .114. All additional results, fit indices, statistically significant factor loadings, and Raykov's rho reliability calculations showed that the identified four-factor, 22 indicator model could serve as a teacher self-assessment of PCK to inform professional development practices.

# CHAPTER V

# DISCUSSION

## Summary of the Study

Studies showed that professional teacher knowledge, identified as PCK, was a significant contributor to students' academic achievement (Gess-Newsome, 2013). Park and Suh (2015) shared there was a need for a valid and reliable PCK measure, so that a relationship between teacher PCK, instructional practices, and student achievement may be identified. Unfortunately, according to Loewenberg Ball et al. (2008) empirical evidence for clear domains of teacher knowledge was lacking and without this evidence, theoretical ideas of teacher knowledge will have a "limited role in improving teaching and learning" (p. 390). Although, research on measuring teachers' PCK had proven to be complex and challenging (Smith & Banilower, 2015) and "characterized…by uncertainty" (Smith & Banilower, 2015, p.88), Jang et al. (2009), Jang (2011), and Lucenario et al. (2016) have effectively utilized the ATPCK as a measure of students' perception of their teachers' PCK in a collegiate setting. Confirmation of construct validity and reliability of the ATPCK as a self-assessment survey with K-12 teachers in a Title 1 school district was the purpose of this study.

Construct validity and reliability of the ATPCK were determined through CFA of self-assessment ratings from Georgia certified K-12 teachers, in a Title I district, at various grade levels, utilizing a non-experimental cross-sectional design. The advantage of non-experimental cross-sectional research was the allowance for data collection across multiple group types at one time, or once during a short window of time (Johnson and

Christensen, 2017). Although the use of this research typology did not allow for the determination of causality, non-experimental research was important in educational research because the manipulation of independent variables could be considered unethical (Johnson and Christensen, 2017).

Jang et al.'s (2009) four-factor, seven loading indicators per factor; the theoretical model was not supported as a teacher self-assessment measure through CFA. However, through CFA "model specification search" (Wang & Wang, 2012, p. 23) practices, a potential theoretical model for a self-assessment measure of teachers' PCK was identified. Through evaluation of correlation matrices, modification indices as well as factor loadings, six indicators were removed systematically from Jang et al.'s (2009) student perception ATPCK, with a maximum of two and a minimum of one indicator being removed from any factor. The final self-assessment theoretical model, identified through CFA model specification search practices, resulted in the retention of Jang et al.'s (2009) theoretical four-factor model. However, the research findings indicated changes to the number of indicators per factor: SMK, retaining five indicators; IOC, with five indicators; KSU, retaining six indicators; and IRS retaining six indicators. The final four-factor, 22 indicator model demonstrated good fit (Table 5) with statistically significant factor loadings (Figure 5). All results, fit indices, statistically significant factor loadings, and Raykov's rho reliability calculations indicated that the identified four-factor, 22 indicators could serve as a teacher self-assessment of PCK to inform professional development practices. This research confirmed the validity and reliability for the utilization of the ATPCK as a self-assessment, so that it may be utilized as a pre-assessment to guide the development of professional learning opportunities, to

formatively assess the professional learning, to ensure the focus of the learning, to determine the effectiveness the learning opportunity, and the next steps in an on-going professional development cycle.

## Analysis of the Findings

To effectively inform and assess professional development practices, identification of a valid and reliable self-assessment measure of teachers' PCK was a valuable step in educational reform efforts. Identification of a valid and reliable measure supported these reform efforts because refining teacher professional development has become a compelling argument for improving instructional practices that may lead to increased student achievement (Akiba & Liang, 2016). Additionally, a self-assessment of teachers' PCK allowed for the establishment of an explicit link between teachers' professional knowledge and instructional practices, providing for future empirical testing that has been currently missing in educational research (Aydeniz & Demit, 2014, Loewenberg Ball et al., 2008). In support of improving teacher knowledge such as PCK, professional development practices must be refined to support and develop teachers' PCK and thereby instructional practices.

Determination of validity and reliability of the ATPCK allowed for its use as a pre-assessment for differentiation of professional development to identified needs of teachers at a district, school, or PLC level. Mahammadi and Moradi's (2017) findings indicated that differentiating professional development practices were advantageous to teachers' buy-in to the professional learning opportunities presented. When teachers believed their individual needs are being addressed, their perception and performance were positively impacted, resulting in improved instructional practices and thereby

improved student achievement (Mahammadi & Moradi, 2017). According to Darling-Hammond (2010) and Mardapi et al. (2018), effective measurement of teacher instructional competencies was as important as the development of the competencies. Regrettably, the assessment of teacher competencies has not often been performed or discussed (Mardapi et al., 2018). Because the ATPCK is a valid and reliable self-assessment measure, the measure could support identifying the professional knowledge needs of teachers creating teacher buy-in to professional development, thereby improving instructional practices and student achievement (Mahammadi & Moradi, 2017).

The effectiveness of PLCs also must be evaluated to ensure teachers are utilizing their learning in practice as well as that PLCs are continually and effectively supporting the needs of teachers (Blitz & Schulman, 2016). Although Blitz and Schulman (2016) identified 49 different PLC assessment tools, none of these tools evaluated the effectiveness of PLCs on the growth of teacher PCK; they were unsuccessful at identifying an assessment for evaluating teachers' professional knowledge growth. Aldahmash et al.'s (2019) meta-analysis indicated that the use of surveys as an assessment of professional development is on the rise and second only to classroom observation. Additionally, assessing teacher knowledge should be a component in the development of professional learning programs, because professional development practices should be "based on deep and thorough investigation" (Aldahmash et al., 2019, p. 173). Use of the ATPCK as a valid and reliable pre- and post-measure of teachers' professional knowledge will help to identify teacher needs, which in turn may be addressed in the context of PLCs, as well as assess the quality of the PLC work and teacher growth through PLC practices.

As a means of assessing professional development effectiveness, Jang et al. (2009), Jang (2011), and Lucenario et al. (2016) utilized the ATPCK as a pre- and post-survey of college students' perception of their teachers' PCK. The ATPCK was administered before professional development interventions provided and then utilized as a post-assessment to determine the effectiveness of the professional development intervention provided (Jang et al., 2009; Jang, 2011; Lucenario et al., 2016). Unfortunately, only Jang et al.'s (2009) initial research provided data for construct validity and reliability of the ATPCK in a collegiate setting. Nevertheless, because the ATPCK survey had shown construct validity and reliability and the current necessity for a way to assess teachers' professional growth in a K-12 setting, this research considered the utilizing Jang et al.'s (2009) ATPCK as a self-assessment of K-12 teachers' professional knowledge growth in the form of PCK. Therefore, validation and confirmation of the reliability of the ATPCK as a self-assessment survey instrument indicated that the measure could be used to improve professional development practices, thereby improving teachers' professional growth in a K-12 setting.

Another factor in professional development assessment is the need to provide outcome data to stakeholders. The U.S. Department of Education, through its Improving Teacher Quality State Grants, provided financial support for professional development (Department of Education, 2015). In order to receive this funding source, the local education authority must show improved student achievement (Department of Education, 2015). However, most student achievement measurers provided lagging data to community and district level stakeholders. Through the validation confirmation of the reliability of the ATPCK, this study has provided a professional development assessment

tool that would deliver outcome data to the community and district level stakeholders for evaluation of a professional development program's effectiveness. Thereby guiding professional development decision-making practices at a district level.

Establishing an explicit link between teachers' professional knowledge and instructional practices and the impact teachers' PCK has been elusive in the absence of empirical testing (Aydeniz & Demet 2014; Loewenberg Ball et al., 2008). Additionally, refining teacher professional development as an educational reform has become a compelling argument for improving instructional practices that may lead to increased student achievement (Akiba & Liang, 2016). To ensure the effectiveness of ongoing professional development programs, differentiation of professional development, and formative evaluation of professional development practices, evaluation of the outcomes resulting from professional development practices must be determined (Blitz & Schulman, 2017; Wynn, 2019). The validation and reliability confirmation of the ATPCK as a self-assessment instrument may provide a potential key component to ensure quality professional development program development and practices. This research proposed the utilization of the ATPCK, when used as a self-assessment, as a valid and reliable measure so that the ATPCK may be utilized as a pre-assessment to guide the development of professional learning opportunities, to formatively assess the professional learning, to ensure the focus of the learning, to determine the effectiveness the learning opportunity, and the next steps in an on-going professional development cycle.

## Limitations of the Study

Limitations of the research design included the non-experimental cross-sectional design and restricted sample size involved in the study, resulting in the lack of a control group or randomization. Although the use of this research typology did not allow for the determination of causality, non-experimental research is important in educational research because the manipulation of independent variables could be considered unethical (Johnson and Christensen, 2017). Though the sample size did not allow for exploratory factor analysis, the sample size did support confirmatory factor analysis practices. Confirmatory factor analysis practices allowed for validation and determination of reliability for the ATPCK, mirroring the validity and reliability practices utilized by Jang et al. (2009) for the original ATPCK survey, as was the intent of this research.

Participation in the research was voluntary and may have resulted in unidentified bias. The selection of the sample for construct validation and reliability of the ATPCK was chosen utilizing purposive sampling techniques. According to Johnson and Christensen (2017), purposive sampling is a "non-random" sampling practice that allows the researcher to solicit input from a population with specific traits. The advantages of purposive sampling include ease of access to participants and no-to-low cost of solicitation for participation (Johnson & Christensen, 2017). Due to the non-random nature of purposive sampling, generalization is limited. However, Johnson and Christensen (2017) expressed that purposive sampling may be used to gain a phenomenological perspective rather than generalizable results. Though research results may not be generalizable, identification of a valid and reliable measure of canonical PCK could prove to be invaluable to support school-level professional development practices

further and advance PCK research. Because the ATPCK was developed to assess canonical PCK rather than content or topic-specific PCK, the researcher did not evaluate content nor the topic-specific application of the ATPCK. Canonical PCK allowed for evaluation of teacher's PCK "within the particular teaching and learning context" (Jang et al., 2009, p. 603) rather than a particular content and topic.

Grade band participation rate may have varied due to participants' familiarity with the researcher, as the researcher has served in both the high school and middle school settings within the research district. Variation of grade band participation rates may have resulted in unidentified bias. Fortunately, due to the canonical design of the ATPCK, potential grade band bias should be minimized.

Finally, Jang et al.'s (2009) original ATPCK survey was utilized for data collection in a collegiate setting in Taiwan (Jang et al., 2009; Jang 2011) and the Philippines (Lucenario et al., 2016). Therefore, the use of this instrument in the United States may have resulted in unanticipated language translation challenges and cultural biases. Unintended bias could have also resulted as a result of participants' interpretation of the Likert scale variables provided, as no clear descriptor for each scale item was provided (Brinker, 2002). Additionally, the use of the ATPCK as a self-assessment in a K-12 setting also may have resulted in indicator context conflicts as well as other unidentified biases. However, due to the overdetermined nature of the ATPCK, identification, and removal of indicator variables should result in minimal impact on the identification of a valid and reliable PCK measure. Because minor variances in response data may be addressed through standard deviation calculations, the impact of biased responses should be minimized (Brinker, 2002).

## Recommendations for Future Research

Exploratory factor analysis (EFA) practices should be considered for additional confirmation of Jang et al.'s (2009) ATPCK domains of teacher knowledge: SMK, IOC, KSU, and IRS. Though this study intended to perform EFA, the limited number of participant responses did not allow for this analysis. Though the removal of indicators was systematically evaluated to ensure gaps in measured context were not created, development and identification of replacement indicators could be supported through the use of EFA practices. Therefore, additional EFA practices would further substantiate and support the domains of PCK as identified by Jang et al. (2009) and further validate the construct validity and reliability of the ATPCK survey.

To provide additional insight into PCK research, a multi-level confirmatory factor analysis could identify potential group effects. However, the purpose of the current research was to confirm the validity and reliability of Jang et al.'s (2009) established ATPCK survey as an assessment of teachers' canonical PCK. As there was no discussion as to the use of multilevel confirmatory factor analysis (MCFA) practices, the current research mirrored the practices utilized by Jang et al. (2009) to confirm the validity and reliability of the ATPCK as a teachers' self-assessment of canonical PCK. Consideration of MCFA for future research could potentially strengthen the use of the ATPCK for canonical PCK application. Additionally, MCFA practices could provide additional PCK insight utilizing demographic data such as gender, years of teaching experience, and grade band. Also, MCFA could potentially allow for the evaluation of teachers' PCK within content areas. MCFA application to demographic data and content area could potentially provide predictive validity to the ATPCK and, in turn, allow for advanced

support for differentiation of professional development practices based on demographics and content area. However, MCFA practices were beyond the scope of this research, which was designed to confirm Jang et al.'s (2009) validity and reliability of the ATPCK.

Although the ATPCK survey indicated construct validity and reliability as a self-assessment in a K-12 Title I school district, additional consideration of adapting the indicator statements should be evaluated. The research findings indicated potential conflicts with the context of statements going from third-party observations to self-reflection statements. Additionally, due to language translations (e.g., Taiwanese to Tagalog), the context of the indicators may not reflect Jang et al.'s (2009) original intention of the indicator. Rewording and revalidating the ATPCK survey indicators could improve the quality of the ATPCK as a self-assessment measure.

Additionally, the frequency data (Table 3) indicated a Likert scale with four options as utilized by Lucenario et al. (2016) could impact the overall quality of results, as the response data required collapsing. Therefore, additional evaluation of the ATPCK as a self-assessment should be considered with Jang et al.'s (2009) original five-option Likert scale.

As professional development practices are not unique to a Title I setting, further evaluation of the ATPCK as a self-assessment of teachers' canonical PCK in a non-Title I school district should be considered. Assessing teacher knowledge should be a component in the development of professional learning programs, regardless of Title I status, because professional development practices should be "based on deep and thorough investigation" (Aldahmash et al., 2019, p. 173). Additionally, refining teacher professional development as an educational reform has become a compelling argument

for improving instructional practices that may lead to increased student achievement (Akiba & Liang, 2015). To ensure the effectiveness of ongoing professional development programs, differentiation of professional development and formative evaluation of professional development practices, evaluation of the outcomes resulting from professional development practices must be determined (Blitz & Schulman, 2017; Wynn, 2018). Use of the ATPCK as a valid and reliable pre- and post-measure of teachers' professional knowledge and growth will help to identify teacher needs that may be addressed in the context of professional development, as well as assess the quality of the professional development opportunities and practices. Additionally, utilizing the ATPCK to identifying growth in teachers' canonical PCK knowledge and then evaluating student growth as a result of improved teacher PCK should be considered. This proposed research could solidify the ATPCK as the elusive link between teachers' PCK growth and student achievement.

## Implications of the Study

The implications of the research findings are numerous, both at a school and district level. Improving teachers' PCK has become a dominate discussion in educational research, and continues to be of significance in teachers' professional development (Wu, 2014). Because teacher PCK has been shown to impact student achievement (Gess-Newsome, 2013) significantly, multiple studies focused on the development of PCK in elementary and secondary pre-service teachers (Aydeniz & Demet, 2014; Barnett, 2015) and in secondary in-service teachers (Evens et al., 2015; Kirschner et al., 2016; Lucenario et al., 2016). However, Smith and Banilower (2015) stated that to effectively evaluate how improved PCK impacts student learning, a quality assessment of PCK must be

developed. Establishing an explicit link between teachers' professional knowledge and instructional practices and how professional development of these components impact teachers' PCK has been elusive in the absence of empirical testing (Aydeniz & Demet 2014; Loewenberg Ball et al., 2008). Though instruments have been developed to measure PCK, these PCK assessments tend to be content and topic-specific. However, the ATPCK was developed by Jang et al. (2009) and utilized by the researcher to assess canonical PCK rather than content or topic-specific PCK. Canonical PCK allowed for evaluation of teacher's PCK "within the particular teaching and learning context" (Jang et al., 2009, p. 603) rather than a particular content and topic. Park and Suh (2015) share that valid and reliable PCK measures for "large-scale use" (p. 105) are necessary for understanding the relationship between teachers' PCK development and improved student achievement. Unfortunately, to date, the assessment of PCK has proven to be a challenge (Ayendiz & Demet, 2014; Jang et al., 2009; Park & Suh, 2015; Smith & Banilower, 2015). The use of the validated ATPCK self-assessment could provide for the elusive empirical link between teachers' instructional practices and PCK as well as teachers' PCK impact on student achievement. Utilizing the ATPCK as a pre and post-self-assessment of canonical PCK could provide for the elusive link between teachers' professional knowledge, PCK, growth, and student achievement.

As a result of their research, Kirschner et al. (2016) postulated the need for targeted professional development in the area of PCK to support pre-service and in-service teachers as a means to improve student achievement. However, Abell et al. (2009) stated that teachers' professional learning needs change as their PCK knowledge develops and that learning occurs in a context, allowing teachers to become participants

in community practices. Abell et al.'s (2009) findings implied that veteran educators' PCK development requires differentiated professional learning opportunities. The use of the validated ATPCK self-assessment of teachers' canonical PCK could allow for differentiation of professional development, resulting in increased professional development buy-in from teachers as well as reducing the likelihood of *problem of enactment* (Kennedy, 2016; Trust et al., 2016). The valid and reliable measure ATPCK could be utilized as a self-assessment to inform the differentiation of professional development, both at the district and school level. When teachers believe that their individual needs are being addressed, their perception and performance are positively impacted, resulting in improved instructional practices and thereby improved student achievement (Mahammadi & Moradi, 2017).

## Dissemination of the Findings

The research outlined in this dissertation was shared with the participating Title I district for consideration of current professional development assessment practices. As per district guidelines, all research carried out in the district must be shared with the Professional Learning Department after the research. Therefore, the completed dissertation was shared electronically, as requested. Additionally, the research findings and dissertation were shared electronically with the researcher's school level administrative team for consideration of utilizing the ATPCK to inform and assess site-based professional development practices. Finally, all participating school principals were informed via email of the completion of the research defense, and an offer to share the research was presented. Upon receipt of principals' requests for research results, an electronic PDF file will be shared.

Dissemination of the research occurred after the final dissertation defense and submittal of required Columbus State University documentation.

## Conclusions

Since the introduction of Shulman's (1986) teacher knowledge *missing paradigm*, PCK, researchers have been trying to determine how to best measure this knowledge (König et al., 2016). The identification of a measure of PCK is important because research shows that PCK as a stand-alone professional knowledge has a positive impact on student achievement (Baumert et al., 2010; König et al., 2016). Unfortunately, most of the research has been focused on the disciplines of math and science and topics specific within these disciplines (Hill et al., 2008; Kelly & Kelly, 2016; Kirschner et al., 2016; Lee & Shea, 2016; Lucenario et al., 2016). Because research has shown that teacher PCK is a strong predictor of student achievement (Baumert et al., 2019), professional development practices should evaluate how to support teachers' PCK growth. Unfortunately, the assessment of PCK has proven to be a challenge (Ayendiz & Demet, 2014; Jang et al., 2009; Park & Suh, 2015; Smith & Banilower, 2015). Nevertheless, assessing teacher knowledge should be a component in the development of professional development practices (Aldahmash et al., 2019), providing support for the necessity of a valid and reliable PCK measure. Therefore, this research looked to identify a valid and reliable measure that could be utilized as a self-assessment of teachers' canonical PCK. The ability to measure teachers' canonical PCK will provide useful data to inform professional learning development and to assess the growth of teachers' PCK as a result of professional development practices.

The use of data to drive decision-making processes has become prevalent in current educational reforms and practices. Unfortunately, the use of data for development and evaluation of quality professional development practices has been lacking. For example, current practices in the identified Title I school district of study allows each school the autonomy to determine professional development needs. Minimal district requirements dictate that professional learning opportunities provided must align with each school's School Improvement Plan (SIP). Therefore, professional development decisions are often based on each school's perceived needs and not necessarily empirical data. Additionally, the impact of professional development provided is evaluated utilizing a standard perception survey, with no evaluation of the professional development impact on instructional practices. (D. Dykes, personal communication, January 25, 2020) However, assessing teacher knowledge should be a component in the development of professional development programs, because professional development practices should be "based on deep and thorough investigation" (Aldahmash et al., 2019, p. 173). Regrettably, Kelleher (2003) stated that the use of assessments to measure professional development is lacking. Though Aldahmash et al.'s (2019) indicated survey to use as an assessment of professional development was on the rise, many of the measures identified by Thurlings and Den Brok (2017) lacked validity and reliability data. Therefore, the identification of a valid and reliable measure of professional development is needed to support quality professional development practices. The findings of this research indicate a valid and reliable self-assessment measure of teachers' canonical PCK in the ATPCK. The use of the ATPCK as a self-assessment of canonical PCK could improve the focus of professional development practices as well as evaluate

the quality of the professional development in measuring teachers' PCK growth. With the ability to empirically measure teachers' canonical PCK growth, the elusive link between teachers' professional knowledge, PCK, and student achievement could be identified and utilized to improve teacher instructional practices and student outcomes further. This research supports the utilization of the ATPCK for use as a valid and reliable self-assessment of teachers' canonical PCK to guide the development of professional learning opportunities, to formatively assess the professional learning, to ensure the focus of the learning, to determine the effectiveness the learning opportunity, and to provide for the next steps in an on-going professional development cycle.

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Appendix A

Demographic/ATPCK Survey

1. Are you a Georgia PSC Certified Teacher? Yes No

2. Gender: Female Male

3. Are you currently working at a Title I school? Yes No

4. Years of experience as a teacher:
   - Less than five years
   - Five to fewer than 10 years
   - 10 to fewer than 15 years
   - 15 and more years

5. The campus where I am currently serving is:
   - Elementary (K-5)
   - Middle (6-8)
   - High (6-12)

**Assessment of Teachers' Pedagogical Content Knowledge (ATPCK)**

**Directions:**

This instrument aims to measure the teachers' pedagogical content knowledge (PCK), focusing on four domains. Please check the column provided describing your perceived knowledge competence for each statement.

| A. SMK (Subject Matter Knowledge) | Never (1) | Seldom (2) | Sometimes (3) | Often (4) |
|---|---|---|---|---|
| 1. The teacher knows the content he/she is teaching.<br>2. The teacher clearly explains the content of the subject.<br>3. The teacher knows how theories or principles of the subject have been developed.<br>4. The teacher selects the appropriate content for students.<br>5. The teacher knows the answers to questions that students ask about the subject.<br>6. The teacher explains the impact of subject matter on society.<br>7. The teacher knows the whole structure and direction of this SMK. | | | | |

| B. IOC (Instructional Objective and Context) | Never (1) | Seldom (2) | Sometimes (3) | Often (4) |
|---|---|---|---|---|
| 1. The teacher helps students clearly understand the objectives of this course.<br>2. The teacher provides an appropriate interaction or good atmosphere.<br>3. The teacher pays attention to students' reactions during class and adjusts his/her teaching.<br>4 The teacher creates a classroom circumstance to promote student interest in learning.<br>5. The teacher prepares some additional teaching materials.<br>6. The teacher copes with the classroom context appropriately.<br>7. The teacher's belief or value of teaching is active and aggressive. | | | | |
| C. KSU (Knowledge of Students' Understanding) | Never (1) | Seldom (2) | Sometimes (3) | Often (4) |
| 1. The teacher realizes students' prior knowledge before class.<br>2. The teacher knows students' learning difficulties of subject before class.<br>3. The teacher's questions evaluate student understanding of a topic.<br>4. The teacher's assessment methods evaluate student understanding of the subject.<br>5. The teacher uses different approaches (questions, discussion, etc.) to find out whether students understand.<br>6. The teacher's assignments facilitate student understanding of the subject.<br>7. The teacher's tests help students realize the learning situation. | | | | |
| D. IRS (Instructional Representation and Strategies) | Never (1) | Seldom (2) | Sometimes (3) | Often (4) |
| 1. The teacher uses appropriate examples to explain concepts related to the subject matter. | | | | |

| | | | | |
|---|---|---|---|---|
| 2. The teacher uses familiar analogies to explain concepts of subject matter.<br>3. The teacher's teaching methods keep me interested in this subject.<br>4. The teacher provides opportunities for me to express my views during class.<br>5. The teacher uses demonstrations to help explain the main concept.<br>6. The teacher uses a variety of teaching approaches to transform subject matter into comprehensible knowledge.<br>7. The teacher uses multimedia or technology (e.g., PowerPoint) to express the concept of the subject. | | | | |

Modified from:

Lucenario, J. L. S., Yangco, R. T., Punzalan, A. E., & Espinosa, A. A. (2016). Pedagogical Content Knowledge-Guided Lesson Study : Effects on Teacher Competence and Students ' Achievement in Chemistry. *Educational Research International*, *2016*, 1–9.

Appendix B

Principal Recruitment Email

Dear Principal,

The purpose of this correspondence is to ask for your participation in a study that is a part of an important project being conducted by me in the fulfillment of my doctoral degree. The purpose of this study will be to validate the Assessment of Teachers' Pedagogical Content Knowledge to support professional development practices. This measure will provide insightful information to guide the differentiation of professional development programs to improve teachers' professional knowledge and thereby improve student outcomes. Please help to validate this potential teacher knowledge survey, so that professional learning opportunities may be targeted to meet your faculty's unique needs. Your feedback will be insightful and informative.

As a principal in the Houston County School District, you have been selected to participate in this study. If you chose to participate in this survey, please click on the following link below and answer all 28 questions. Your answers are confidential and completing this survey will only take 15-30 minutes. The first question of the survey will prompt you to review Informed Consent. If you wish to continue and participate in this research study, simply select "I agree."

This research study has been reviewed by the Columbus State University Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. If you have any questions or comments regarding this survey, please feel free to contact me by e-mail moore_jami@columbusstate.edu. You may also address questions to my dissertation chair, Dr. Deirdre Greer, at 706-507-8505 or by e-mail at greer_deirdre@columbusstate.edu.

Thank you very much for helping us with this important study.

Survey link:

Sincerely,

Jami M. Moore
Doctoral Candidate
Columbus State University

# Appendix C

## Educator Recruitment Email

Dear Valued Educator,

The purpose of this correspondence is to ask for your participation in a study that is a part of an important project being conducted by me in the fulfillment of my doctoral degree. The purpose of this study will be to validate the Assessment of Teachers' Pedagogical Content Knowledge to support professional development practices. This measure will provide insightful information to guide the differentiation of professional development programs to improve teachers' professional knowledge and thereby improve student outcomes as well as assess the effectiveness of professional development practices. Please help to validate this potential teacher knowledge survey, so that professional learning opportunities may be targeted to meet your faculty's unique needs as well as provide insight into your current professional development practices. Your feedback will be insightful and informative.

As an educator in the Houston County School District, you have been selected to participate in this study. Please click on the following link provided below to answer the five demographic and 28 survey questions. Your answers are confidential and completing this survey should only take 15-30 minutes. The first question of the survey will prompt you to review Informed Consent. If you wish to continue and participate in this research study, simply select "I agree."

This research study has been reviewed and approved by the Columbus State University Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. If you have any questions or comments regarding this survey, please feel free to contact me by e-mail Moore_jami@columbusstate.edu. You may also address questions to my dissertation chair, Dr. Deirdre Greer, at 706-507-8505 or by e-mail at greer_deirdre@columbusstate.edu.

Thank you very much for helping us with this important study.

Survey link:

Sincerely,

Jami M. Moore
Doctoral Candidate
Columbus State University

Appendix D

Web-Based Informed Consent

You are being asked to participate in a research project conducted by Jami M. Moore, a doctoral student in the Counseling, Foundations, and Leadership department at Columbus State University. Dr. Deirdre Greer, a professor at Columbus State University, serves as the faculty member supervising this study.

**I. Purpose:**

The purpose of this study will be to confirm the construct validity and reliability of the Assessment of Teachers' Pedagogical Content Knowledge (ATPCK) as a self-assessment survey with K-12 teachers in a Title I school district.

**II. Procedure:**

You will receive a link directing you to SurveyMonkey®. This online measure will contain a Demographics Survey and an Assessment of Teachers' Pedagogical Content Knowledge survey. The duration to complete both surveys is 15-30 minutes. The data collected for this research project will not be used in future research projects.

**III. Possible Risks or Discomforts:**

To minimize risks or discomforts, the data collected will not be linked to the participants in this study.

**IV. Potential Benefits:**

The confirmation of validity and reliability of the ATPCK could provide an assessment tool to guide, formatively assess, and determine the effectiveness of both district and school-level professional development practices.

**V. Cost and Compensation:**

Participants will not receive compensation for participating in this study. There will be no financial cost for participating.

**VI. Confidentiality:**

To ensure confidentiality, IP addresses of participants will not be recorded. The electronic data will be stored on the researcher's personal laptop and external hard drive, which are password protected. No personally-identifying information will be obtained. The data will be deleted six months after the completion of the research study.

**VII. Withdrawal:**

Your participation in this research study is voluntary. You may withdraw from this study at any time, and your withdrawal will not involve penalty or loss of benefit.

For additional information about this research project, you may contact me, Jami M. Moore, at 478.273.9470 or moore_jami@columbusstate.edu.

If you have questions about your rights as a research participant, you may contact the Columbus State University Institutional Review Board at irb@columbusstate.edu.
I have read this informed consent form. If I had questions, they have been answered. By selecting the *I agree* radial and *Submit*, I agree to participate in this research project.

● I agree ● I do not agree

Submit

@hcbe.net;