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New Era of Teaching, Learning, and Technology: Teachers' Perceived Technological Pedagogical Content Knowledge and Self-Efficacy Towards Differentiated Instruction

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Abstract

Shifting from an industrial model of education to a model that best provides students with differentiated instruction (Tomlinson, 2014) requires educational philosophical change (Fullan, 2014) as well as innovation diffusion (Rogers, 2003). The problem is not the amount of research that exists on differentiation, the diffusion of innovations, or the change process. The problem is what new technological pedagogical content knowledge (Koehler & Mishra, 2008) do educators need to make this change process happen? How is this knowledge communicated to finally change the "fundamental processes of schooling" (Elmore, 1996, p. 4)?

This sequential, mixed-methods study addressed the following condensed research questions: What are in-service teachers' perceived knowledge levels in relation to technological pedagogical content knowledge (TPACK)? What are teachers' perceived levels of comfort to differentiate instruction (DI)? Is there a significant relationship among perceived levels of comfort to DI and TPACK? What are the relationships between educators' TPACK and DI self-efficacy and the following demographics: grade level, years of teaching, adopter category, device-student ratio, professional development hours in technology or DI, class size, certification(s), and educational background?

A questionnaire with open-ended questions provided quantitative and qualitative data (N=72). On a 5-point (*SD – SA*) Likert scale, pre-kindergarten to grade 12 teachers self-perceived TPACK ranged from 3.46 to 4.00. The educators' self-efficacy to DI (5-point; *Not Confident-Very Confident*) was 4.01 and DI with technology (DI-T) was 3.16. Grade 8-12 teachers demonstrated significantly higher TPACK and self-efficacy to DI than pre-kindergarten to grade 4 teachers.

Of the respondents, 22% were categorized as innovators and 32% as early adopters-considered teacher leaders. Both groups demonstrated more confidence with DI-T than later adopter categories. Even with significant correlation between TPACK and DI (r=.47, r^2= .22; p < .001), TPACK and DI modeling ranged from 2.20 (teachers) to 1.75 (teacher leaders) and from 2.32 to 2.03 respectively (1=*25% or less* to 4=*76-100%).*

Qualitative themes confirmed the problem. Even though TPACK and self-efficacy to DI were relatively strong, these innovative practices were being rejected. Thus, recommendations identified specific professional development needs, and for educational systems to create communication channels to more rapidly diffuse innovational pedagogies.

Introduction

Differentiated instruction is an instructional practice based in constructivist theories. Meeting all learners' individual needs in a diversified environment is a common mantra of public school mission and vision statements, as well as national legislation. While most teachers agree with the premise and design of differentiating the process, content, product, and environment (Tomlinson, 2008; Appendix A), the diffusion of this innovative best practice is slow to materialize (Hargreaves, 2006; Tomlinson, 2014). Thus, educational leaders must close the gap between innovational best practices and technological innovations in order to diffuse differentiated instruction throughout the system (Collins & Halverson, 2009; Fullan, 2014; Houle & Cobb, 2011; Prensky, 2000, 2010; Renzulli & Reis, 2012; Stanford, Crowe, & Flice, 2010; Tomlinson, 2014).

Problem Statement

Most 21st century public school systems remain didactic environments, stagnant in their attempts to successfully focus on the incorporation of innovative pedagogies and practices (Darling-Hammond, 2010; Fullan, 2014; November, 2014; Prensky, 2010; Robinson, 2010, 2011; Washor & Mojkowski, 2013). On the other hand, technological advances outside of school open access to innovative, personalized learning opportunities that are literally at a student's fingertips (Vander Ark, 2012). Fifteen years into the 21st century, public systems cannot claim 21st century skills as novel, and still universal acceptance of the use of technological innovations in both practice and technology to transform learning within the classrooms has not occurred (Collins & Halverson, 2009; Fullan, 2014; Houle & Cobb, 2011; November, 2014). Thus the goal of engaging and soliciting higher-level achievement of individual learners of today is only evidenced in so-called isolated classrooms (Tomlinson, 2014).

How do systems effectively diffuse innovations of effective practice into public systems (Fullan, 2014)? Fullan and Langworthy (2013) warned educators and leaders against focusing only on the technology, "The focal point is 'deep learning goals' enabled by new pedagogies accelerated by technology" (p. 4). Building professional capacity with respect to innovative pedagogies, not technology itself, is considered the right driver for change in America's public education system (Fullan, 2014).

Small steps in the right direction occurred, in early 2000, when differentiated instruction (DI) slowly moved into mainstream education. Differentiated instruction, considered innovative by most educators (Robinson, 2010; Tomlinson & Imbeau, 2012), addressed the students' cultural, gender, wealth, aptitude, and interests variances present in modern day classrooms (Tomlinson & McTighe, 2006). Empirical evidence, although slowly being accumulated, demonstrated that DI increased student engagement, achievement (Hall, Strangman, & Meyer, 2011; Tomlinson, 2000), and provided the opportunity of reducing achievement gaps for underrepresented groups (Stavroula, Leonidas, & Mary, 2011). However, Tomlinson and Imbeau (2012) concluded that teachers were not implementing this practice because it was too difficult to employ with the number of students on caseload, the number of standards required to cover, and because of the perception to keep pace with other teachers. Casey (2011) also found that teachers lack a universal understanding of the differentiated instruction concept.

Parallel to this occurring in school systems, an explosion of technological innovations outside of school made individual learning accessible to those with digital access (Kahn, 2012). In contrast, only a small amount of change has actually occurred in public education even though educational technology is widely believed to offer teachers an easier opportunity to differentiate instruction (Kahn, 2012; Fullan, 2014; November, 2014; Rosen & Beck-Hill, 2012; Tomlinson, 2014). Prensky (2000) forecasted that students themselves would dismantle the barriers currently keeping personalized learning out of the classrooms. Education "will continue to resist for a while yet, like the Berlin Wall in the political world, when it finally falls there will be a stampede to freedom" (Prensky, 2000, p. 4). Whether or not this stampede will head in or out of public education, however, is to be determined.

Background of Study

History of Differentiated Instruction

In the early 1900s, John Dewey (1987) coined the term *participatory learning* (as cited in Cunningham, 2009, p. 46). Dewey believed a best practice of instruction began with the understanding of individual children's interests, and how the learning directly connected to a student's life. However, the majority of teaching and learning throughout the 20th century was not personal (Kahn, 2012; Prensky, 2010). The philosophy of

Mann’s “common” schooling continued well into the 1900s to create “curriculum of the Industrial Age America, to prepare children to become moderately educated citizens...in this mechanized, industrial society” (Houle & Cobb, 2011, p. 12).

As America transitioned from the Industrial Age to the Information Age and then quickly to the Conceptual Age in the late 1900s, so did the way people sought to learn and innovation spurred a new educational reality (Pink, 2005). As this new reality coupled with the need of the United States to compete globally, the call was made for teaching and learning to change (Freidman, 2005) and for students to be prepared with 21st century skills-creativity, collaboration, critical thinking, and communication-for a quickly innovating world (Pink, 2005).

In the mid-1970s, Renzulli (2000) developed an schoolwide enrichment model (SEM) for gifted education that quickly disseminated throughout regular education (Renzulli & Reis, 2012). This approach differed from traditional giftedness that focused on the deductive, didactic learning found traditionally in an industrial model of education. SEM sought to develop “creative-productive giftedness [that] enables children to work on issues and areas of study that have personal relevance,” Renzulli and Reis (2012) continued to explain that SEM “can be escalated to appropriately challenging levels of investigative and creative activity” (p. 21). Similar to other theorists, such as Dewey (1937) and Vygotsky (2008), Renzulli’s framework was rooted in the beliefs that 1) each student is unique, 2) student engagement is key, 3) content and process should be delivered in meaningful real-world context, and 4) the goal of teacher is to construct instruction that allows each student to create meaning (Renzulli & Reis, 2012).

From SEM and the theories that supported the model, the theory of *Differentiated Instruction* (DI; Tomlinson, 2000, 2008) was developed. DI focused on the content, process, product, and learning environment as directly related to individual students (Tomlinson, 2000, 2008). “The model of differentiated instruction requires teachers to be flexible in their approach to learners rather than expecting students to modify themselves for the curriculum” (Hall, Strangman, & Meyer, 2011, p. 1). By removing traditional, one-size fits all instruction, differentiation supported learning promotes the expertise, creative thinking skills, and motivation necessary to innovate (Wagner, 2012).

As the millennium changed, the theory of differentiation also began to evolve with the rapid increase of technological advancements. Renzulli and Reis (2012) noted that new technologies allowed, “the kinds of scaffolding that consumes more time than most teachers can devote to individualized learning” (p. 28). In fact, the National Education Technology Plan (NETP, 2010) challenged teachers to effectively use technology to step beyond differentiation to engage in the practice of personalized instruction. Personalized learning environments (PLE) combined differentiation and individualization with learning objectives, content, method and pace all varied to meet individual learning needs and goals (NETP, 2010, p. 12). “It’s doubtful personalized learning could happen-or at least happen well-without the right technological tools already in place” (Greaves as cited in Demski, 2012, p. 34). Thus, across the country, educational leadership was challenged to create technological infrastructures and develop collective capacities to support innovative pedagogies (Weston & Bain, 2010).

Change

Change is often characterized into two parts: first order change and second order change (Fullan, 2005) or technical and adaptive change (Heifetz & Laurie, 2001). Greaves, Hayes, Wilson, Gielniak, and Peterson (2012) determined that most educational changes have historically been first order changes; thus participants believed “existing organizational goal and structures are basically adequate” (p. 6). On the other hand, second order change identifies a shift from the status quo and signals a change in philosophy, methodology, routines, and structure of organizations (Greaves et al., 2012). Cuban (1988, as cited in Greaves et al., 2012) stated, “Second-order changes, on the other hand, aim at altering the fundamental ways of achieving organizational goals because of major dissatisfaction with the current arrangements” (p. 7).

However, second-order change, like that being sought for 21st century education, change that contributes to a more profound effect on learning, is still in the early adoption stage and faces resistance from stakeholders (Collins & Halverson, 2009; Cunningham, 2009; Houle & Cobb, 2011; Prensky, 2010; Trilling & Fadel, 2009; West, 2011, 2012). Heifetz and Laurie (2001) reasoned, “Second, adaptive change is distressing for the people going through it. They need to take on new roles, new relationships, new values, new behaviors, and new approaches to work" (p. 4). The collision between technological and educational change contributed to this unrest:

> Lessons that can be learned from reviewing the history of technology integration in the K-12 educational environment is that technology integration is not easy to implement because it represents a second-order change. There are some steps that can be taken to help teachers make that change such as increasing the number of computers in their classroom (Becker, 2001); but the most important step that can be taken is to develop a process of professional learning that creates a shared meaning about technology. It is this shared meaning which will allow teachers to overcome their uncertainty and anxiety caused by this change. (Shattuck, 2007, p. 10)

To create this shared meaning, the International Association for the Evaluation of Educational Achievement (2003) published, "in order to fully realize technology's capabilities for reinventing teaching, learning, and schooling, policy makers must engage in sustained, large-scale, simultaneous innovation in curriculum, pedagogy, assessment, professional development, administration, organizational structures, strategies for equity and partnerships" (p. x). Rogers (2003) termed the diffusion of such innovation as the "process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 34), and that "an innovation is an idea, practice, or object perceived as new by an individual or other unit of adoption" (p. 35). Therefore, i*nnovators*, *early adopters*, *early majority*, *late majority*, and *laggards* are members of an organization that communicate to decide on acceptance or rejection of innovation (Rogers, 2003). Elmore (1996) reasoned that the segregation between innovators and laggards limited the ability of an innovation to have substantial impact on learning and teaching.

Leadership is key to the successful movement of stakeholders through the change processes (Fullan, 2005; Greaves et al., 2012, Rogers, 2003). "Capacity building involves developing the collective ability-dispositions, skills, knowledge, motivation, and resources-to act together to bring about positive change" (Fullan, 2005, p. 4), and Fullan also argued that:

> There is no chance that large-scale reform will happen, let alone stick, unless capacity building is a central component of the strategy for improvement. Related to this, we now know that capacity building *throughout the system* at all levels must be developed in concert, and to do this will require powerful new system forces. (p. 11)

Bandura (1977) stated, to change behaviors stakeholders must be "given appropriate skills and adequate incentives..." but continued on to stress, "...however, efficacy expectations are a major determinant of people's choice of activities, how much effort they will expend, and of how long they will sustain effort in dealing with stressful situations" (p. 194).

There is overwhelming evidence that technology is being diffused rapidly and that second order change related to how people learn is happening exponentially outside of public education (Friedman, 2005). Thus, change agents from both inside of and outside of the traditional, industrial-modeled walls of education prophesized that this innovative, paradigm change must also be diffused throughout education, otherwise students will be ill-prepared to compete in the global society (Friedman, 2005; Prensky, 2010; Trilling & Fadel, 2009).

Technology, Pedagogy, and Content Knowledge

Futurist Prensky (2010) boasted "never in human history have children had access to the knowledge of the world until the Digital Natives" (p. 62); but "year after year, students in our focus groups remind us that their dissatisfaction with using technology at their school is not about the quantity or quality of the equipment or resources; it is about the unsophisticated use of those tools by their teachers, which they believe is holding back their learning potential" (Project Tomorrow, 2013, p. 7). Rosen and Beck-Hill (2012) purported that this is a result of a "technocentric" approach in which technology is "used for technology-related activities rather than innovative, technology-rich learning environment conceptually designed and practically implemented as a method for paradigmatic change of teaching and learning" (p. 228). Other researchers urged leadership to provide professional development to increase teacher capacity to design personalized lessons with higher level thinking skills which are tantamount to furthering differentiated instruction, in contrast to low-level thinking skills such as drill and practice (Jackson et al., 2008; Marzano, 2009).

Historically, teachers designed lessons to implement curriculum using three components: a) content knowledge, b) pedagogical knowledge, and c) curricular knowledge (Shulman, 1986). However, this historical understanding is expanding to include technology knowledge (Harris & Hofer, 2009; Koehler & Mishra, 2008). Koehler and Mishra (2008) termed this new theoretical framework as *technological pedagogical content knowledge* (TPCK or TPACK; Appendix B). "TPACK is a form of professional knowledge that technologically and pedagogically adept, curriculum-oriented teachers use when they teach" (Harris, Mishra, and Koehler, 2009, p. 401). Therefore, to study both differentiation and TPACK is to study a "technology cluster...interrelated innovations that complement each other in a way that adoption of one innovation might naturally lead to adoption of one or more of the other innovations" (Meyer, 2004, p. 60).

> Given the ever evolving nature of educational research and practice, and of TPACK's defining elements, it is clear that what we face is at once a tall order and an appealing opportunity: to continue to invent, revise, expand, update, test, and otherwise explore the ways in which we understand and help teachers to develop TPACK. Due to the emergent and interdependent nature of this particular type of professional, applied knowledge, this can be best accomplished as a collaborative endeavor among content experts, educational technology developers, educational researchers, and pedagogical practitioners. We invite our readers to join us in this worthy endeavor. (Harris, Mishra, & Koehler, 2009, p. 413)

Research Questions

The following research questions guided this study:

1. What are in-service teachers' perceived knowledge levels in relation to the overall dimension of technological pedagogical content knowledge (TPACK) and the following sub-dimensions: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK)?
2. What are the in-service teachers' perceived levels of comfort to differentiate instruction?
3. Is there a significant relationship among perceived levels of comfort to differentiate instruction and the overall dimension of technological pedagogical content knowledge (TPACK) and the following sub-dimensions of TPACK: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK)?
4. How do teachers describe their use of technology to differentiate instruction?

Methodology

The research approach for this study was mixed methods (QUAN-qual) using a sequential design and was pragmatic in its worldview. In a pragmatic research philosophy, "instead of focusing on methods, researchers emphasize the research problem and use all approaches available to understand the problem" (Creswell, 2009, p. 10).

Data Collection

Participants (*N* = 180) were first invited to participate in the first of the study via email. Of those returned (*N* = 90), the researcher reviewed patterns in the partially completed surveys and found that 72 (40%) were viable responses (having completed the majority or all of the questions).

For the first construct, a permission request was sent to two of the lead researchers for the following surveys: *Survey of Pre-service Teachers' Knowledge of Teaching and Technology* (Schmidt, Baran, Thompson, Koehler, Mishra, & Shin, 2009) and *The TPACK for Meaningful Learning Survey* (Koh, Chai, & Tsai, 2014). In addition, the modified survey was combined with questions from the *Survey of Beginning Teachers' Perceived Preparedness and Efficacy for Differentiating Instruction* (Casey, 2011).

Quantitative Analysis

Quantitative data were analyzed through the use of SPSS-22.0. Research questions 1 and 2 were analyzed using item-level within dimension frequencies, percents, ranked means, and standard deviations. One-way ANOVAs then measured whether there were significant differences between TPACK levels and extent of differentiation. Follow-up Scheffé tests were completed, where necessary. Question 3 was analyzed by creating scatterplots to check for linearity between the two variables (i.e., TPACK and self-efficacy). The relationships were linear, thus Pearson's product–moment correlations was employed.

Qualitative Analysis

To protect against threats to validity when analyzing results, two open-ended responses followed the quantitative questionnaire. This qualitative data were analyzed through thematic coding of the "predefined themes" (Beck, 2014). Prior research finds "the challenges inherent in assessing teachers' knowledge accurately via self-reports" (Hofer, Grandgenett, Harris, & Swan, 2011, p. 4352), thus this analysis began with Krippendorff's techniques of clustering and the construction of a dendrogram (as cited in Beck, 2014), followed by a process to confirm conclusions.

Major Findings

A questionnaire with open-ended questions provided quantitative and qualitative data (*N*=72). On a 5-point (*SD* – *SA*) Likert scale, pre-kindergarten to grade 12 teachers self-perceived technological pedagogical content knowledge (TPACK) and the TPACK sub-dimensions ranged from 3.46 to 4.00 (Table 1).

Table 1

Descriptive Statistics for TPACK Dimensions (N = 72)

Dimension	*M*	*SD*
Technological Knowledge (TK)	3.46	.95
Pedagogical Knowledge (PK)	4.42	.46
Content Knowledge (CK)	4.53	.58
Technological Content Knowledge (TCK)	4.00	.70
Pedagogical Content Knowledge (PCK)	4.02	.66
Technological Pedagogical Knowledge (TPK)	3.40	.79
Technological Pedagogical Content Knowledge (TPACK)	4.00	.64

Note. Item responses were: 1 = *Strongly Disagree,* 2 = *Disagree,* 3 = *Neither Disagree or Agree,* 4 = *Agree*, 5 = *Strongly Agree*

The educators' self-efficacy to differentiate instruction (DI) (5-point; *Not Confident-Very Confident*) was 4.01 and DI with technology (DI-T) was 3.16 (Table 2).

Table 2

Descriptive Statistics for Dimension 8 and 9: Self-efficacy to Differentiate Instruction (DI) and Self-efficacy to Differentiate Instruction with Technology (DI-T) (N = 72*)*

Dimension	*M*	*SD*
Differentiate Instruction (DI)	4.01	.65
Differentiate Instruction with Technology (DI-T)	3.16	1.02

Note. Item responses were: 1 = *Not Confident,* 2 = *Somewhat Confident,* 3 = *Undecided,* 4 = *Confident*, 5 = *Very Confident*

Table 3 displays the quantitative data indicating several correlations between teachers' self-efficacy to differentiate instruction and pedagogical knowledge (PK) (r = .51, r^2 = .26; p < .001), technological content knowledge (TCK) (r = .34, r^2 = .12; p < .001), pedagogical content knowledge (PCK) (r = .28, r^2 = .08; p < .05), technological pedagogical knowledge (TPK) (r = *.27*, r^2 = *.01*; p < *.05*), and technological pedagogical content knowledge (TPACK) r = .47, r^2 = .22; p < .001). There were also several correlations between an educator's efficacy to employ technologically supported differentiated instruction (DI-T) and the dimensions of technological knowledge (TK) (r = .56, r^2 = .31; p < .001), technological content knowledge (TCK) (r = .56, r^2 = .31; p < .001), technological pedagogical knowledge (TPK) (r = .77, r^2 = .59; p < .001), and technological pedagogical content knowledge (TPACK) (r = .46, r^2 = .21; p < .001).

Table 3

Bivariate Correlations and Effect Sizes Among Dimensions

Subscale	TK		PK		CK		TCK		PCK		TPK		TPACK		DI		DI-T	
	r	*r*[2a]	*r*	*r*[2a]	*r*	*r*[2a]	*r*	*r*[2a]	*r*	*r*[2a]	*r*	*r*[2a]	*r*	*r*[2a]	*r*	*r*[2a]	*r*	*r*[2a]
TK	--	--	-.08	.01	-.10	.00	.49**	.24**	-.10	.01	.71**	.50**	.23*	.05*	-.07	.00	.56**	.31**
PK			--	--	.32*	.10*	.26*	.07*	.43**	.18**	.19	.04	.45**	.20**	.51**	.26**	.28*	.08*
CK					--	--	.10	.01	.25*	.06*	.03	.00	.20	.04	.23	.05	.01	.00
TCK							--	--	.03	.00	.67**	.45**	.59**	.35**	.34*	.12*	.56**	.31**
PCK									--	--	-.06	.00	.24*	.06*	.28*	.08*	.06	.00
TPK											--	--	.55**	.30**	.27*	.07*	.77**	.59**
TPACK													--	--	.47**	.22**	.46**	.21**
DI															--	--	.37**	.14**
DI-T																	--	--

Note. Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Pedagogical Content Knowledge (TPACK), Self-efficacy to Differentiate Instruction (DI), and Self-efficacy to Differentiate Instruction with Technology (DI-T)
**p < .05; N = 72*
***p < .001*
[a]*Effect size: .01 = large; .09 = medium; .25 = large*

Even with significant correlation between TPACK and DI *(r*=.47, *r* ^{2}= .22*; p* < .001)*,* TPACK and DI modeling ranged from 2.20 (teachers) to 1.75 (teacher leaders) and from 2.32 to 2.03 respectively (1=*25% or less* to 4=*76-100%)* (Tables 4 and 5).

Table 4

Frequencies of Perceived Technological Pedagogical Content Knowledge (TPACK) Modeling by Member Categories

Position		Frequency				*M*	*SD*
		25% or less	26-50%	51-75%	76-100%		
Self	*f*	16	24	20	10	**2.34**	.99
	%	**22**	**33**	**28**	**14**		
Teachers	*f*	16	27	26	2	**2.20**	.82
	%	**22**	**38**	**36**	**3**		
Teacher Leaders	*f*	39	13	26	2		
	%	**54**	**18**	**37**	**3**	**1.75**	.92
Administrators	*f*	38	19	13	2		
	%	**53**	**26**	**18**	**3**	**1.70**	.86

Note. Item responses were 1 = *25% or less,* 2 = *26-50%*, 3 = *51-75%*, 4 = *76-100%*

Table 5

Perceived Differentiated Instruction (DI) Modeling by Various Member Categories

Position		Frequency				*M*	*SD*
		25% or less	26-50%	51-75%	76-100%		
Self	*f*	12	16	25	16	**2.65**	1.03
	%	**17**	**23**	**36**	**23**		
Teachers	*f*	15	27	22	8	**2.32**	.93
	%	**21**	**38**	**31**	**11**		
Teacher Leaders	*f*	35	15	15	6		
	%	**49**	**21**	**21**	**9**	**1.69**	.83
Administrators	*f*	37	22	11	2		
	%	**51**	**31**	**15**	**3**	**1.69**	.83

Note. Item responses were 1 = *25% or less,* 2 = *26-50%*, 3 = *51-75%*, 4 = *76-100%*

Research Question #6: Key Qualitative Findings

- The qualitative responses indicated differentiation occurred most often in content areas-the “what to teach” (Tomlinson, 2014).
- Qualitative findings support the premise that those demonstrating stronger pedagogical content knowledge also feel more confident in their ability to differentiate instruction.
- Five out of the 47 responses (11%) to the first open-ended response, “Describe a specific episode where you effectively demonstrated or modeled differentiated instruction (DI)...” noted that there had not been an opportunity to teach a lesson in this manner.
- The final qualitative theme to emerge during analysis of this last step was the limited variety of programs or websites when describing technology integration or lack of technology knowledge to support differentiation or when describing technological pedagogical content knowledge.
- From the descriptions of differentiated practices, many would be classified as not being effective models of differentiation in one or more of the following areas: content, process, product and environment.

Through “eye-balling” the data and checking initial inferences against field notes and initial data, the results began the confirmation process of the quantitative findings. In particular, the findings clearly confirmed the quantitative data that participants had strong content knowledge and in turn, content was the most popular way to differentiate instruction. Strong technological pedagogical content knowledge (TPACK) was evident in responses that also demonstrated strong teacher self-efficacy to differentiate with technology.

During the final qualitative analysis step which asks the researcher to “tie the inferences with theory; go beyond descriptive summation toward explanation” (Miles, Huberman, & Saldana, 2013, p. 117), the qualitative data supported the literature and confirmed the problem that these innovative practices were not being thoroughly diffused throughout this social system. Thus, while checking the conclusions through confirmation and checking tactics, including reviewing the literature review and member checking, the analysis verified that further phases in this mixed-methods study were not necessary.

Pragmatic Discussion of Findings

The knowledge levels and modeling percentage were important findings because historically, teachers developed knowledge in three areas: a) content knowledge, b) pedagogical knowledge, and c) curricular knowledge (Shulman, 1986). The more developed this pedagogical content knowledge, the more proficient educators were in delivering the curriculum via best instructional practices (Jacobs, 2010). Researchers today expand that historical understanding to include technology knowledge (Harris & Hofer, 2009; Koehler & Mishra, 2008). Koehler and Mishra (2008) termed this new theoretical framework as “technological pedagogical content knowledge” (TPCK or TPACK). Therefore, consistent with the literature, the data in this study suggests that the participants have sufficient knowledge to begin the process of integrating technology as a “pedagogical tool” (Hu & Fyfe, 2010, p. 184).

In addition, literature suggests that there is a necessity of leadership groups to be the champions of the change. Thus, an essential element in the change processes is transformational leadership (Senge, 2000). There are certain types of leadership necessary for “transforming organizations to meet adaptive challenges and become knowledge-generating vs. merely knowledge-using organizations...[this] requires very different kinds of leaders-ones who recognize that they, as individuals may have to change in order to lead the necessary organizational changes” (Wagner, Kegan, Lahey, Lemons, Garnier, Helsing &...Rasmussen, 2006, p. 11). The leadership categories assessed in this study, teacher leaders and administrators, have a low-percentage of modeling TPACK and therefore do not represent these leadership qualities. The literature suggests the lack of knowledge modeling by these leaders stymies the possibility for transformation to occur (Senge, 2000), and thus more research may be needed on TPACK of administrators to truly understand this suggestion.

The importance of educator efficacy levels and modeling percentage is necessary to understand as well due to the pragmatic nature of the study because knowledge is a contributor to self-efficacy (Bandura, 1997). Thus similar to TPACK, and supportive of the same literature, the data suggested the first stage, knowledge collection, of the process in which acceptance or rejection of DI as an innovation has already occurred (Rogers, 2003). However, also similar to TPACK, the modeling of DI in actual practice was low. For example, participants ranked themselves (*M* = 2.65), other teachers (*M* = 2.32), and teacher leaders (*M* = 2.03) as modeling DI to the greatest extent, between 51-75% of the time. However, administrators only modeled DI effectively between 26-50% of the time. Conversely, DI-T self-efficacy levels are neutral (*M* = 3.16) suggesting that members are still in the first diffusion of innovation stage-collecting knowledge (Rogers, 2003).

In addition, the correlations between the dimensions were both consistent and inconsistent with literature in several ways. In particular, participants with strong perceived pedagogical knowledge (PK) also demonstrated an increased confidence in their ability to differentiate instruction (DI). However, contradictory to the literature, those with strong content knowledge (CK) did not demonstrate an increased confidence to differentiate instruction nor to using technology to support differentiated instruction (DI-T). In addition, strong CK only somewhat influenced participants' self-efficacy to differentiate instruction, and this had no impact on DI-T.

Also noteworthy is the fact that while CK is not significantly correlated to DI or DI-T in the study, the overwhelming majority of qualitative responses collected described content and content related areas-standards, skills, problem-solving, further investigation-as areas most often differentiated. Since research deems these areas as an essential components to DI, then the findings in this study may signal a need to change to a more progressive view on the "what" to be taught in schools; one that connect technology to content knowledge and pedagogical knowledge. Results also reveal a strong correlation between self-efficacy to employ technologically supported DI and strong technological content knowledge (TCK)-an understanding of the manner in which technology and content influence and constrain one another-and strong technological pedagogical content knowledge which:

> Encompasses understanding and communicating representations of concepts using technologies; pedagogical techniques that apply technologies appropriately to teach content in differentiated ways according to students' learning needs; knowledge of what makes concepts difficult or easy to learn and how technology can help redress conceptual challenges; knowledge of students' prior content-related understanding and epistemological assumptions, along with related technological expertise or lack of thereof; and knowledge of how technologies can be used to build on existing understanding to help students develop new epistemologies or strengthen old ones. (Harris, Mishra and Koehler, 2009, p. 401)

Also important to note, the qualitative findings caused pause when reflecting back on the quantitative data. The findings supported the quantitative findings. However, the themes that emerged also signaled the necessity for more in-depth technology pedagogical content knowledge. TPACK and the activity types that are part of this knowledge enables educators the ability to leverage these innovational practices in order to avoid techno-centric behaviors, and on the other hand, allows the exploitation of technology to increase student achievement and engagement (Koehler & Mishra, 2008). The teachers who reflected on their differentiation, overwhelming reported differentiating through content, and did not reflect strong understanding of how to employ differentiation in process, product, or environmental ways.

The heavy reliance on content knowledge when differentiating instruction, combined with the lack of quantitative correlation of content knowledge (CK) or pedagogical content knowledge (PCK) to an educator's self-efficacy to differentiate instruction, seemingly supports the literature that content is now "Google-able" (Houle & Cobb, 2009). According to their qualitative responses, teachers seemingly are unaware of the need for changing this focus; yet according to their quantitative correlations, this change may be happening in spite of this lack of awareness (Evans, 2002). Therefore, the lack of correlation of CK to DI or DI-T in the quantitative findings compared with the heavy reliance on CK in the qualitative reflections signals a significant need to shift teacher development since teacher preparation and professional development heavily focuses on content knowledge (Darling-Hammond & Bransford, 2005).

In addition, more research will be needed to determine if teacher's begin to realize the need for change in this mindset, and begin to seek more opportunities to develop in areas related to their technological content knowledge (TCK) and technological pedagogical knowledge (TPK) along with keeping up with the continually fluctuating technological knowledge (TK) and updated pedagogical knowledge (PK), in order to increase their confidence to differentiate instruction.

Recommendations

#1: Create a strategic growth plan with a clear mission that takes into account the innovation adoption process (Rogers, 2003) and goals that include "strong external normative structures for practices; develop organizational structures that intensify and focus, rather than dissipate and scatter, intrinsic motivation to engage in challenging practice, create intentional processes for reproduction of successes; and create structures that promote learning of new practices and incentive systems that support them. (Hargreaves & Fullan, 2009, p. 18-25).

#2: In an effort to increase the use of technology to support more effective differentiated instructional practices in the classrooms, provide teachers with embedded, differentiated professional development (Slepkov, 2008) that does not focus only on the technology, but rather focuses on technological pedagogical content knowledge (TPACK) as it relates to differentiated instruction (DI). This is a significant shift in how professional development is developed, implemented and assessed in order to build these capacities (Hofer, Grandgenett, & Harris, 2010; Jacobs, 2010; West, 2011).

#3: In an effort to increase the use of technology to support more effective differentiated instructional practices in the classrooms, provide targeted professional development on related topics of technological pedagogical content knowledge (TPACK) and differentiated instruction (DI) to other member groups specifically teacher leaders and administrators.

#3: In an effort to increase the use of technology to support more effective differentiated instructional practices in the classrooms, increase the communication with and connection to exemplars.

Additional Research. This study suggests that leadership categories, administrators and teacher leaders, have a low-percentage of modeling TPACK knowledge. However, empirical studies are lacking on the self-reported knowledge levels of specifically administration with respect to the constructs studied in this research-technological pedagogical content knowledge and differentiated instruction. Thus, further educational research targeting those responsible for shaping the processes is necessary to understand the conditions that must exist in order to fully combat this problem of scale.

Summary

Content, pedagogy, and technology knowledge enhances differentiated student learning and engagement (Collins & Halverson, 2009; Demski, 2012; Houle & Cobb, 2011; Prensky, 2000, 2010; Renzulli & Reis, 2012; Stanford, Crowe, & Flice, 2010; West, 2012). However, in order for the integration of technology in the classroom to move beyond simple web searches, teachers must have the capacity to include technological pedagogical content knowledge effectively and efficiently in their lessons (Koehler and Mishra, 2008). This complex knowledge theory is necessary if educators are to include differentiated instruction, address misconceptions using various representations, determine prior knowledge, and provide deep learning opportunities (Fullan, 2014; Harris, Mishra, & Koehler, 2009).

Greenstein (2012) made a call to action:

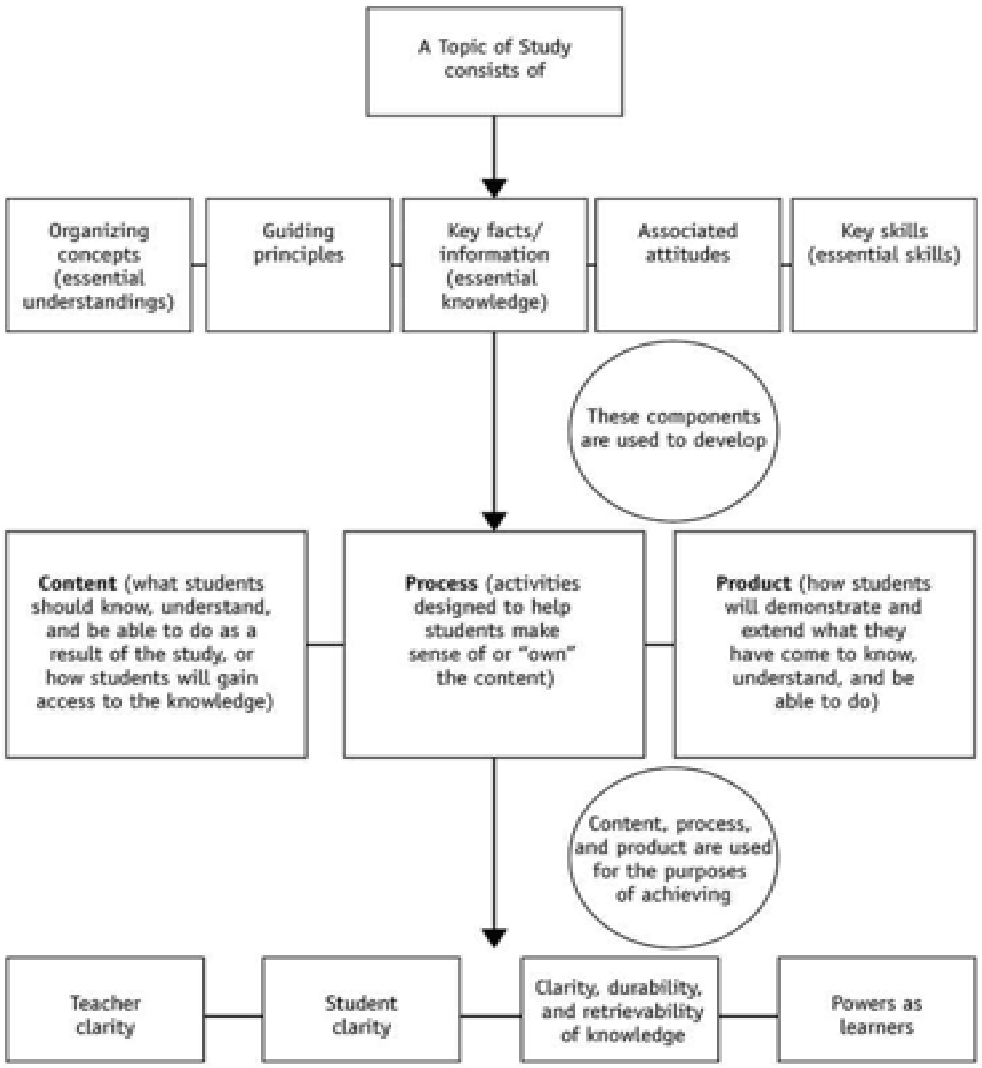
> At the same time that dramatic technological and social changes are occurring, research continues to illuminate what good teaching looks like...These techniques for effective teaching can and should be coordinated with new technologies so that each supports the other. (p. 128)

Innovative schools are creating strategic professional growth plans that integrate personalized learning goals and objectives intertwined with teachers as facilitators within a substantive technological infrastructure. With technology being rooted within the system and the view that students should be directly at the center of the learning, this research and resulting recommendations expanded on the elements that are necessary to build teacher self-efficacy in the effective navigation of transformational learning and teaching of the 21st century (Enydey, 2014; Fullan, 2014; Littky & Allen, 1999; November, 2014; Tomlinson, 2014; West, 2012).

Appendix A

Differentiated Instruction Model

Joining the Levels of Learning and Elements of Curriculum



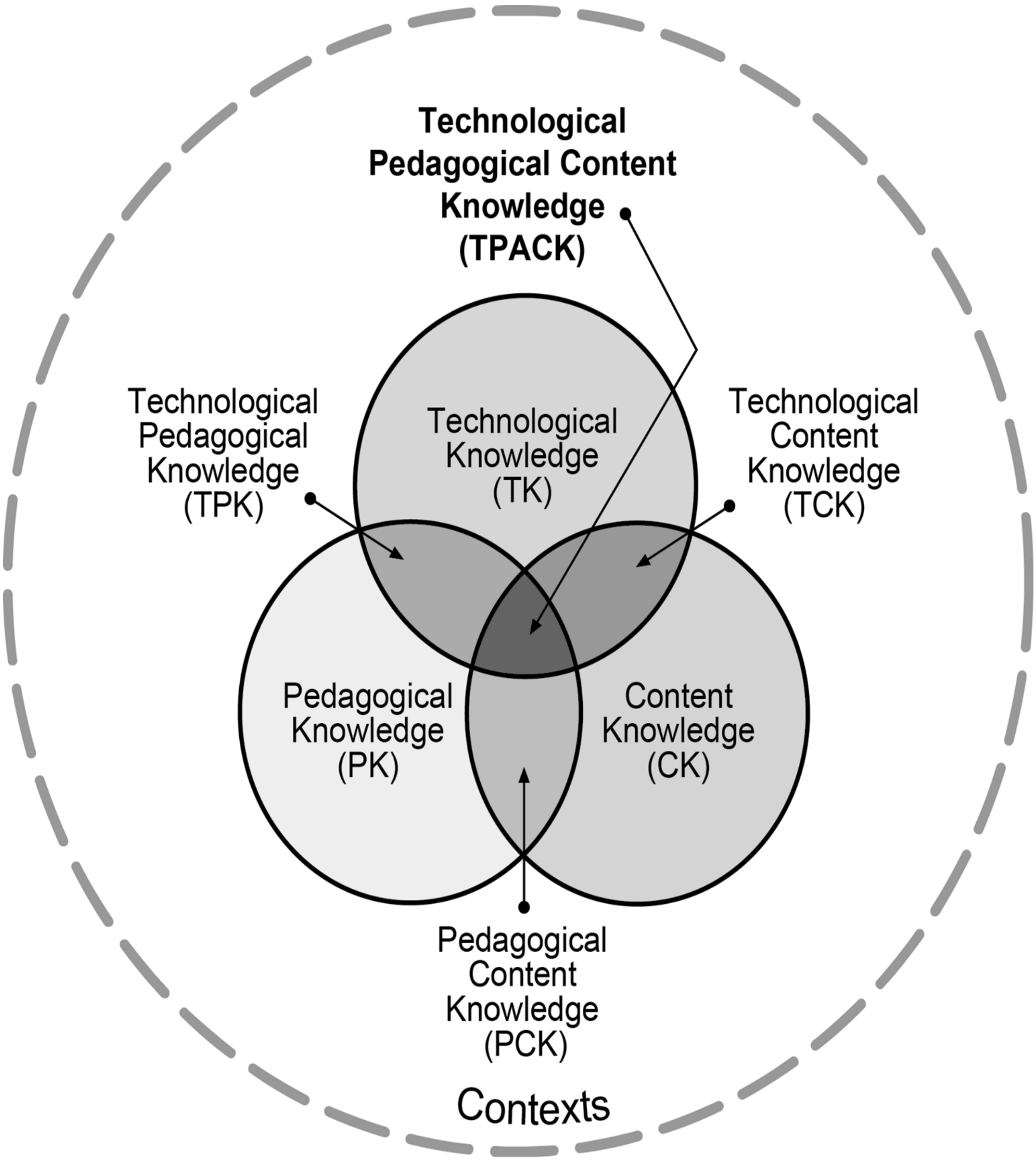
(Tomlinson, 2014, Location 1269)

Definition of Term:

Differentiated Instruction (DI): a theory-based teaching and learning process that adjusts the instructional process-the content, process, and product-to meet individual needs of students in a classroom (Tomlinson, 2000).

Appendix B

TPACK Construct



Definition of Terms:

Content Knowledge (CK): subject area knowledge as this knowledge relates to effective teaching and learning (Koehler & Mishra, 2008)

Pedagogical Knowledge (PK): the necessary knowledge of the practices required to teach effectively such as "what representations, examples, analogies are particularly useful in helping students grasp particular concepts or ideas" (Darling-Hammond & Bransford, 2005, p. 208).

Pedagogical Content Knowledge (PCK): knowledge of pedagogy and content knowledge to combine to include "an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" (Shulman as cited in Darling-Hammond & Bransford, 2005, p. 205).

Technological Knowledge (TK): knowledge of existing and innovative technologies (paper to digital) as technology relates to effective teaching and learning (Koehler & Mishra, 2009).

Technological Content Knowledge (TCK): knowledge of technology and content that combine in a way that "transforms" learning and teaching in a way not possible without technology (November, 2014).

Technological Pedagogical Knowledge (TPK): knowledge of pedagogy and technology that combine in a way that effective teaching and learning is only possible through innovative pedagogies and accelerated by digital (Fullan, 2014).

Technological Pedagogical Content knowledge (TPACK):

> Encompasses understanding and communicating representations of concepts using technologies; pedagogical techniques that apply technologies appropriately to teach content in differentiated ways according to students' learning needs; knowledge of what makes concepts difficult or easy to learn and how technology can help redress conceptual challenges; knowledge of students' prior content-related understanding and epistemological assumptions, along with related technological expertise or lack of thereof; and knowledge of how technologies can be used to build on existing understanding to help students develop new epistemologies or strengthen old ones. (Harris, Mishra and Koehler, 2009, p. 401)

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