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TPACK Integration for 21st Century Teacher Education

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Abstract: ***The widespread use of technology improves daily life and provides many benefits to people. Technologies can transform the way we think about teaching and learning. Technological methods are among the most important tools in and out of school in the educational process of pupils and teachers. Teachers in schools have a role to play in incorporating technology into the teaching process. For this purpose, teacher education services should provide pre - service teachers with adequate training for changing instructional practices enriched with creative educational technologies. Training through the TPACK model in teacher education enables pre - service teachers to determine a "fit" between the curriculum focus, pedagogical strategies, and digital or non - digital technologies. Hence this paper throws a light on TPACK and the need for its implementation in teacher education.***

Keywords: ICT, TPACK, PCK, TCK, TPK

1. Introduction

Today's generation of learners has been referred to as the "NET Generation, " a group with a higher preference for experiential and hands - on learning (Oblinger and Oblinger 2005). According to Prensky (2001), "Our students have fundamentally changed. Today's students are no longer people who our education program was equipped to teach. Keeping these growing needs of learners, a number of schools in India have introduced technology - enabled solutions to transact information in the classroom. The information and communication technology (ICT) tools that are commonly used today include interactive whiteboards, projectors, computers, laptops, tablets and smartphones. Typical Indian classrooms, once characterized by students sitting through hour - long teacher monologues, are increasingly seeing the use of digital technology solutions to engage a generation of knowledge - based learners in technology. However, technology is much more an add - on in schools than an integral part of school curricula.

The current generation of learners is more competent and fluent in the use and application of emerging technologies than their teachers. They are "digital natives, " while their teachers are "digital immigrants" (Prensky 2001). The effectiveness of technology in the classroom depends, therefore, on how it is used, by whom, for what purpose, and on the changes in behaviour that it brings to the learners (Lavin et al 2009).

Studies suggest the need for complementary growth in teaching - learning approaches and ICT use, complementing each other in an exciting way. According to Condie and Munro (2007), the introduction of technology into classrooms would demand new methods of communicating knowledge to learners and a shift in the role of teacher from "expert" to moderator, facilitator or guide. Koehler and Mishra (2009) suggest a paradigm in which teachers hold technical, pedagogical and content expertise as a single whole in order to be able to effectively incorporate new technology solutions into their everyday teaching - learning practices.

Need for integration of technological practices in teacher education.

Pre - service teacher education plays a significant role in influencing the use of new technology tools available to teachers in the classroom (Gao et al 2009; Lim et al 2010). In addition, teachers who have earned ICT training in their teacher education courses show a greater ability to use technology in classrooms and a greater sense of self - efficiency in relation to the use of digital technology in classrooms (Brown and Warschauer 2006; Hammond et al 2009). Effective integration of technology in classrooms depends on how teachers and students embrace and use technology in their everyday classroom practice. A number of studies have shown that teachers' values, knowledge, skills and attitudes are crucial to the effective adoption of ICT (Hew and Brush 2007). One study noted that, while teachers have a deep desire to integrate ICT with education, they experience challenges such as lack of confidence and competence, negative attitudes and inherent resistance to ICT integration (Bingimlas 2009). Students, including teachers, are key participants in the application of ICT in classrooms. And, unlike teachers, students are much more open to ICT usage for day - to - day teaching activities, with a large number of students claiming that ICT makes them more successful learners (Edmunds et al 2012).

A common challenge in training teachers for ICT integration is that many teachers do not have adequate exposure to the pedagogical use of emerging technology solutions. Many institutes of teaching offer only one technology course for teacher training, where the main emphasis is on improving ICT skills. It is important to remember that the learning of ICT skills on its own does not sufficiently prepare teachers to incorporate ICT into their day - to - day teaching activities (Chai et al 2010). According to Koehler and Mishra (2009), the effective use of ICT in the classroom involves teachers to integrate technological tools (Gaver 1991) with pedagogical solutions to the particular subject matter to be taught. The TPACK framework developed by Mishra and Koehler offers a clear theoretical framework for the integration of technology with content and pedagogy.

What is TPACK?

Mishra and Koehler's (2006) TPACK framework, which focuses on technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), Offers a constructive solution to many of the dilemmas that teachers face in integrating educational technology in their classrooms. By distinguishing between these three categories of expertise, the TPACK structure explains how content (what is taught) and pedagogy (how the teacher communicates the content) will form the basis for any successful integration of technology in education. This order is important as the technology being applied will communicate content and facilitate pedagogy in order to improve the learning environment of students.

According to the TPACK framework, specific technical resources (hardware, software, apps, associated information literacy activities, etc.) are ideally used to instruct and guide students towards a stronger, more comprehensive understanding of the subject matter. Thus, the three forms of information – TK, PK, and CK – are combined and recombined in various ways within the TPACK system. Technological pedagogical knowledge (TPK) describes the relationships and interactions between technological methods and traditional pedagogical methods, while pedagogical content knowledge (PCK) describes the same relationship between pedagogical practices and specific learning objectives; and, ultimately, technological content knowledge (TCK) describes the relationships and interactions between technology and learning objectives. These triangulated areas then constitute TPACK, which considers the interaction among all three areas and acknowledges that educators are working within this dynamic environment.

TPACK is based on the work of Shulman (1986) who proposed a blend of pedagogy, content and knowledge (PCK) as the key to effective teaching practices. Rather than providing information on content and knowledge separately, Shulman demonstrated the strength of the overlap between the two constructs. To resolve the increasing need for guidance on technology integration, Koehler and Mishra (2009) extended Shulman's PCK model by introducing an additional dimension to technology. Mishra and Koehler, have developed TPACK in the absence of any other appropriate theory to describe or guide successful educational technology integration. After its publication in 2006, TPACK has been one of the leading ideas on educational technology integration: all research and professional learning programs draw strongly on it.

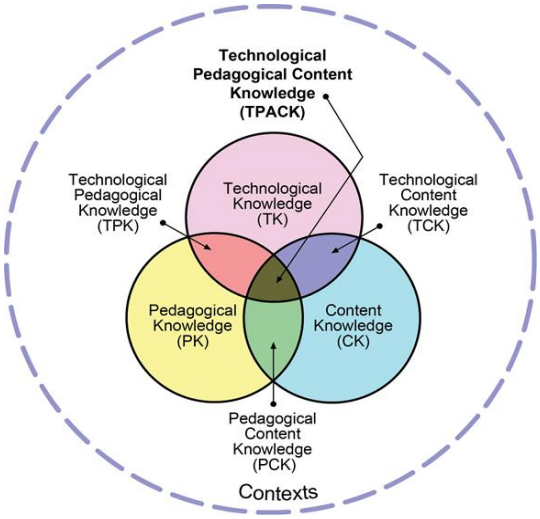

Figure 1: TPACK framework (Koehler & Rosenberg, 2014)

However, TPACK has remained such an influential concept for almost 12 years, as the diverse components mentioned above make way for a variety of different educational circumstances. Any successful application of technology in the classroom needs an understanding of the complex, transactional relationship between content, pedagogy, and growing technologies – all within the particular framework of various classes, classrooms, and cultures. Factors such as the individual teacher, the specific grade level, the composition of the class and more will mean that any scenario would require a slightly different approach to educational technology integration. No monolithic combination of content, pedagogy, and technology can adhere to every context, and TPACK leaves space for practitioners to adapt its framework to different circumstances.

This adaptability can be seen in the different intersections and relationships already in the TPACK acronym.

- **Content Knowledge (CK)** – This represents the teacher's own knowledge of the subject. CK may include knowledge of concepts, theories, facts and organizational frameworks for a given subject matter.
- **Pedagogical Knowledge (PK)** – This defines teachers' comprehension of teaching and learning activities, procedures and techniques. As a generic form of knowledge, PK covers the goals, values, and aims of education and can refer to more specific areas, including the understanding of student learning styles, classroom management skills, lesson planning, and evaluation.
- **Technological Knowledge (TK)** – This defines the experience and willingness of teachers to use various technology, technological tools and associated resources. TK is concerned with understanding educational technology, considering the implications for a given subject or classroom, continuing to know whether it improves or hinders learning, and continuously learning and evolving to emerging technology offerings.
- **Pedagogical Content Knowledge (PCK)** – This represents the knowledge of teachers in specific areas of teaching and learning, including curricula development, and student assessment. CK focuses on the promotion of learning and the tracking of links between pedagogy and its supporting practices (curriculum, assessment, etc.). The PCK aims to improve educational activities by

building better links between the content and the pedagogy used to communicate it.

- **Technology Content Knowledge (TCK) –** It explains teachers' knowledge of how technology and content can influence and drive against each other. TCK includes understanding how the subject matter can be conveyed across various technologies and determining which different technological resources are better tailored to specific subjects or classrooms.
- **Technological Pedagogical Knowledge (TPK)** – This describes teachers' understanding of how particular technologies can change both the teaching and learning experiences by introducing new pedagogical affordances and constraints. Another aspect of TPK concerns understanding how such tools can be deployed alongside pedagogy in ways that are appropriate to the discipline and the development of the lesson at hand.

TPACK is the result of these various combinations and interests, drawing from them – and from the three larger underlying areas of content, pedagogy, and technology – to create an effective basis for teaching using educational technology. For teachers to make effective use of the TPACK framework, they should be open to certain key ideas, including:

- Concepts from the content being taught can be represented using technology,
- Pedagogical techniques can communicate content in different ways using technology,
- Different content concepts require different skill levels from students, and educational technology can address some of these requirements,
- Students come into the classroom with different backgrounds – including prior educational experience and exposure to technology – and lessons utilizing educational technology should account for this possibility,
- Educational technology can be used in tandem with students' existing knowledge, helping them either strengthen prior epistemologies or develop new ones.

Implementing TPACK in Teacher Education

Although it is difficult to prepare pre - service teachers for all the technical innovations that are to emerge throughout their careers, they will begin the acquisition of their TPACK as soon as they join the teacher education system (Milner - Bolotin et al., 2013). pre - service teachers should be interested in learning about innovations as a method to help support educational goals. Therefore, to prepare teachers - candidates for a successful teaching career in the 21st century, they will have to undertake several support systems throughout their teacher education programme. Training in the TPACK model would certainly enhance their teaching skills once they become teachers.

Training in TPACK should support student teacher in:

- Learning how to utilize educational technologies as enablers of big pedagogical ideas;
- Experiencing active technology - enhanced engagement as learners and as teachers;
- Adopting pedagogical values congruent with this technology - enhanced active engagement;
- Designing and implementing technology - enhanced educational materials that serve clear pedagogical purposes.

In teacher training programmes, students can build their TPACK in a variety of programs and field experiences. A variety of researchers have started to investigate the effectiveness of various approaches to TPACK production in the field of education technology. One technique for assessing TPACK growth over time is to use pre - and post - treatment exposure assessments. In their study of Pre - Service Teachers in the Educational Technology Course in Singapore, Koh, Chai and Tsai (2010) used the survey of Pre - Service Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009) to begin and conclude a 3 - credit course. Chai et. al concluded that the participants made substantial improvements in CK, PK, TK and, most importantly, in TPACK with relatively large effect sizes. In analyzing the interactions between domains, the findings indicate that PK had the biggest impact on TPACK.

Ozgun, Koca, Meagher, and Edwards (2010) conducted a study of students in a mathematics teaching methods course on the mechanisms for pre - service teachers' development of the pedagogical knowledge necessary for effective use of such technologies. Participant surveys and collected assignments were analyzed through the lens of the TPACK framework. The results indicate that the participants' understanding of technology shifted from viewing technology as a tool for reinforcement into viewing technology as a tool for developing student understanding. Collected data supported the notion that pre - service teacher TPACK development is closely related to a shift in identity from "learners of mathematics" to "teachers of mathematics". In a class where advanced digital technologies were used extensively as a catalyst for promoting inquiry - based learning, pre - service teachers retained a great deal of skepticism about the appropriateness of using technology in concept development roles, despite their confidence that they can incorporate technology into their future teaching.

Jang and Chen (2010) examined the impact on a transformative model of integrating technology and peer coaching for developing technological pedagogical and content knowledge (TPACK) of pre - service science teachers. A transformative model and an online system were designed to restructure science teacher education courses. Participants of this study included an instructor and 12 pre - service teachers. The main sources of data included written assignments, online data, reflective journals, videotapes and interviews. This study expanded four views, namely, the comprehensive, imitative, transformative and integrative views to explore the impact of TPACK. The model could help pre - service teachers develop technological pedagogical methods and strategies of integrating subject - matter knowledge into science lessons. The researchers suggest that the model helped the participants better understand PCK and TPACK. Additionally, the participants were able to model their own technology integration lessons after those of their mentors. The analysis and reflection on video recordings of their lessons helped them synthesize their knowledge of "students' learning difficulties (relative

to specific content foci), instructional strategies, and technology"

Figg and Jaipal (2009) conducted a cross - case study of four pre - service elementary teachers' efforts to integrate technology into their 7 weeks of practice teaching experiences, used multiple data sources including questionnaires, interviews, and classroom observations. The researchers organized a design - team experience in which the pre - service teachers collaborated with their supervising teachers and technology consultants to design and implement a series of technology - integrated lessons. The findings suggest several implications for technology teacher educators. First of all, a focus on instructional design (guidance in planning) and implementation strategies and techniques specific to teaching with a technology need to be included in any technology course for pre - service teachers. Addressing these needs before practice teaching may promote successful initial experiences implementing technology - enhanced lessons and reduce the use of trial and error during the practicum. The comfort level with technology and confidence to teach with the technology were positively affected when initial experiences were successful. The study further suggests that even though pre - service teachers may be very skilled in computer use (TK) and have a broad knowledge of the technology appropriate for their subject matter content (TCK), there is still a pedagogical component that is unique to teaching with technology (TPK). They recommended that types of knowledge pre - service teachers should learn or experience before implementing technology - enhanced lessons in classrooms and provide specific guidance to teacher educators as to basic foundational TPACK that should be included in computer courses for pre - service teachers.

Karakaya, Ozlem. (2017) conducted a study to investigate the relationship between pre - service teachers' self - reported TPACK and their performance in integrating educational technology into lesson plans. The study also attempted to explore how pre - service teachers integrate digital technologies into their lesson plans that were designed as a course assignment. The study suggested that improving pre - service teachers' technological knowledge should not only be restricted to educational technology courses. In fact, Teacher education programs should redesign various methods courses (like literacy, science, social studies, math) to help pre - service teachers design lesson plans not only with content and pedagogical knowledge but also with technological knowledge.

Mark Hofer & Neal Grandgenett (2012) investigated to find how pre - service teachers' knowledge for technology integration develops during their teacher preparation program? Which areas of their knowledge develop most naturally, and which areas require more scaffolding? It was a mixed method including a descriptive study of pre - service teachers enrolled in an 11 - month M. A. Ed. program; they sought to trace the development of participants' technological pedagogical content knowledge (TPACK) over time. Comparisons of self - report surveys, structured reflections, and instructional plans at multiple data points spanning the three - semester program revealed significant development of the participants' technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK), but only limited growth in technological content knowledge (TCK).

Hence, from the above studies it is evident that teacher training sessions under the TPACK system seek to develop a thorough understanding of the complex relationship of technology with teaching, learning and content / subject representation and its communication to students (Chien and Chang 2015). The creation of TPACK among teachers is important because it allows teachers to choose and combine different learning activities, taking into account the learning needs and preferences of students. Research indicates that only when teachers are familiar with a full range of learning practice types in a particular subject can they effectively select and execute the activity (Rocha et al 2011).

Transition in Educational Scenario post COVID - 19

Post Covid - 19 pandemic, the education scenario is forced to transit from face to face classes to online education. But unfortunately, most of the present teachers are finding it difficult to adopt online teaching as they have limited knowledge of integration technology with their content and pedagogical knowledge. Hence, it is need of an hour to incorporate technology in teaching learning process. The teacher education what is provided now is not able to prepare technological driven competent teachers to handle online classes. The prospective teachers must be trained to integrate appropriate technology along with content and pedagogical knowledge. It's easy to think that adding an asynchronous or synchronous technology would enhance learning. This is exactly why the TPACK framework is important. It helps teacher to understand the relationship between technology, content, and pedagogy, and the purposeful blending become the key of success. In a study conducted by Australasian Society for Computers in Learning in Tertiary Education, researchers found that the TPACK framework enhanced teacher candidates' ability to use technology in their learning and later in their professions.

"This present understanding of the use of TPACK, " author of the study Dr. Dorit Maor explains, "also paves the way for educators to engage students in collaborative learning and to develop the concept of digital pedagogies. Digital pedagogies may be the concept that can encompass all: teaching approach, students' attitudes, and desired learning outcomes". Further the author adds that the framework should also be used to develop new forms of professional development "to promote a better understanding of the synergy between technology and pedagogy." Given its potential impact on teachers, teacher training, professional development, and student outcomes, claiming that TPACK is an important concept in education may be an understatement.

2. Conclusion

Success in technology - enhanced pedagogy should not be judged by the extent of the use of technology, but by the impact of technology used to achieve specific pedagogical objectives. Thus, TPACK becomes essential part of education system which incorporated the growing demand

for technology in education. This can be accomplished by combining technology with content and pedagogy using the TPACK training model. While pre - service teachers can obviously enhance their academic, pedagogical and content knowledge on a stand - alone basis, integrating these types of knowledge into the development of their TPK, TCK and TPACK gives them a more comprehensive view of their teaching and helps them move from student teacher to a competent teacher.

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