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The EMPIRe Model as a Thinking Tool to Prepare Teachers for Technology Integration

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Abstract: *The importance of integrating technology into the teaching and learning of K-12 education and preparing teachers for technology integration has long been recognized. This paper presents a review of the research literature on the barriers and challenges of preparing teachers for technology integration. This paper also covers a critical analysis of the theoretically and empirically based measures proposed in previous literature to deal with these barriers and challenges. Based on the literature review and the critical analysis, the EMPIRe model is proposed in this paper as a thinking tool facilitating teachers' learning of technology integration. Potential applications of the EMPIRe model are also discussed.*

Keywords: technology integration, technological skills, pedagogical beliefs, self-efficacy, technological pedagogical content knowledge (TPCK)

1. Introduction

In a century of amazingly rapid development of technologies, the potential of using technology to transform teaching and learning environment and to improve learning outcomes has long been acknowledged. Technology integration related knowledge and skills are consequently recognized as an important component of an educator's knowledge base (ISTE, 2002, 2008). The U.S. Department of Education (2002) launched the "Enhancing Education through Technology Program" with the goal "to facilitate the comprehensive and integrated use of educational technology into instruction and curricula to improve teaching and student achievement" (U.S. Department of Education, 2004, p. 1). With increasing attention and emphasis given to technology integration, the past several decades in the U. S. have witnessed various professional development programs sponsored by federal, state, and local educational agencies and professional organizations to prepare in-service teachers for integrating technology into their classrooms. Meanwhile, educational technology courses are added into teacher education programs' curricula to help pre-service teachers develop skills related to technology integration.

Going alongside with the inexorable trend of preparing in-service and pre-service teachers for technology integration is the "technologizing" of U. S. schools. According to the report of U.S. National Center of Education Statistics (Wells & Lewis, 2006), the ratio of students to instructional computers with Internet access in 2005 was 3.8 to 1, a decrease from 12.1 to 1 in 1998, and from 4.4

to 1 in 2003. However, extensive efforts to prepare teachers for technology integration and increased classroom access to computer and Internet are not accompanied by an equal growth of quality technology integration. Technology integration practices against the true spirit of technology integration are not uncommon, and low levels of classroom technology use are still prevalent (Barron, Kemker, Harmes & Kalaydjian, 2003; Cuban, Kirkpatric, & Peck, 2001; Mishra & Koehler, 2006). What is technology integration in its real sense and why it is important? This paper seeks to provide a better understanding to these questions and, more importantly, to search for better ways to prepare teachers for technology integration based on a review of the barriers and challenges related to preparing teachers for technology integration.

2. Literature Review

2.1. Technology Integration: Definition, Advantages, and Status Quo

Technology is a term that may inclusively refer to "the making, usage, and knowledge of tools, machines, techniques, crafts, systems or methods of organization in order to solve a problem or perform a specific function, or the collection of such tools, machinery, and procedures" (Technology, n.d., p. 1). However, it is a prevailing public perspective to associate technology to computer when talking about educational technology and such association is also prominent in research when the term technology integration is referred (Bauer & Kenton, 2005; Ertmer, 2005; Lawless & Pellegrino, 2007; Valdez, McNabb, Foertsch, Anderson, Hawkes, & Raack, 2000). So the discussion of technology integration in this paper will limit to the integration of computer-based or related technologies.

Although the literature is replete with research and reports on technology integration, a common and consistent definition of this term is disturbingly unavailable. While technology integration is generally understood from the broad perspective of relating it to instructional practices and improved learning (Lin & Lu, 2010; U.S. Department of Education, 2004), it is also approached from more focused perspectives like enhancing student problem solving and critical thinking abilities (Jonassen & Reeves, 1996; Koç, 2005). When introducing the "Enhancing Education through Technology Program," former U.S. Secretary of Education Rod Paige (U.S. Department of Education, 2002) pointed out that "It's not enough to have a computer and an Internet connection in the classroom if they are not turned on. It's not even enough to turn them on if they are not integrated into the curriculum, and it's pointless to integrate them into the curriculum if they don't add value to student performance" (p. 2). Equally insightful is Hamilton's (2007) definition of "what integration is not":

> Integration is NOT the use of managed instructional software, where a computer delivers content and tracks students' progress. Integration is NOT having students go to a computer lab to learn technical skills while the classroom teacher stays behind to plan or grade papers. Integration is NOT using the Internet to access games sponsored by toy manufacturers or popular television shows. Integration is NOT using specialty software for drill and practice day after day. Integration does NOT replace a teacher with a computer (p.21).

Central to the Paige's and Hamilton's NOTs are the ideas that technology integration is not to place computers into classrooms to replace teachers and we need to "resist the seductive power of technology to replace rather than enhance" (Munoz, 1993, p. 49). The ultimate purpose of technology integration is to improve learning process and student achievement. This purpose is not achieved by technology per se, but by how technology is used (Bernauer,1995; Mishra & Koehler,2006). To achieve the purpose, our teachers, as the most direct and most important determinant of how technology can be used, need to make pedagogically sound decisions about technology uses in their classrooms. If technology has no pedagogical wisdom (Fullan, 2000), teachers are the ones who are able to endow technology with such wisdom.

The purpose here is not to attempt a definition attending to each and every aspect of technology integration. Rather, the purpose of discussing technology integration here is to emphasize and highlight the idea of viewing technology integration as a systematic process involving the designing, implementing, and reflecting of instructional technology uses. In this systematic process, teachers play a central role and technology is but one of the elements, not a sole element, to achieve the ultimate goal of improving learning experience and student achievement.

As Callister (1992) states, “Machines are tools, valuable only when human intelligence organizes their use in productive ways” (p. 324). The idea of productive use of technology is critical in technology integration. In technology integration, technology needs to be incorporated productively into teaching and learning than serving as an add-on or decorative touch to other elements in the teaching and learning process.

When it comes to the advantages of technology integration, they are not without empirical evidence. In a meta-analysis study (Waxman, Lin, & Michko, 2003) commissioned by the U.S. Department of Education’s Northwest Central Regional Education Laboratory, 42 studies from peer-reviewed articles about the impact of educational technology on student learning outcomes were analyzed. The results from the study indicate that teaching and learning with technology has positive and statistically significant effect on overall student outcomes (including cognitive and affective outcomes) as compared to traditional instruction. This meta-analysis yielded an effect size twice as large as the mean effect size of nine meta-analysis studies conducted during 1997-2000, indicating that “the overall effects of technology on student outcomes may be greater than previously thought” (p.15).

Other advantages resulting from integrating technology into instruction include improved reading and writing abilities, enhanced cooperative learning, enriched opportunities for learner-control, increased motivation, increased access to worldwide information and connections to real world, and increased teacher communication (Kulik, 2003; Valdez et al., 2000; Venezky,2004). While we need to embrace these reported advantages with reservation because of quality or methodological issues associated with technology integration research (Hannafin, Orrill, Kim, & Kim, 2005; Valdez et al., 2000), we have to be aware that technology itself does not necessarily entails the above mentioned advantages. Effective technology integration is indispensable of teachers’ planning, pedagogical knowledge and skills (Bernauer, 1995; Coppola, 2004). As noted by Coppola (2004), “technology enables teachers with well-developed working theories of student learning to extend the reach and power of those theories; in the absence of these powerful theories, technology enables mediocrity” (p. xii).

Limited access to technology resources was identified as a prominent barrier to technology integration (Hope, 1997; Leggett & Persichitte, 1998; Pelgrum 2001). However, with 94% K-12 instructional rooms in the

U.S. having computers with broadband Internet access and the ratio of student to computer connected to Internet reaching 3.8:1 in 2005(Wells & Lewis, 2006), access to technology resources is less of a problem today. There has been a shift in research in recent years to focus more on teacher-related barriers such as beliefs, skills, and attitudes (Brinkerhoff, 2006; Lin & Lu, 2010; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Hermans, Tondeur, van Braak, &Valcke, 2008). Such a shift in research focus is understandable and even encouraging because teachers are the planners and implementers of technology integration. Focusing on teacher-related barriers may prove to be more promising in yielding insights about what needs to be done to improve technology integration practices.

The term "an apparent paradox" was used in a study conducted among teachers in two high schools (Cuban et al, 2001) to refer to the situation that outstanding access to technology resources was only accompanied with non-use or infrequent low level use of technology for sustaining common teacher-centered teaching practice. Two reasons identified in this study for such a situation were time issues and computer and software training issues. The "high access vs. low use" paradox are well-documented in technology integration research (Becker, 2001; Culp, Honey, & Mandinach, 2005; Ertmer, 2005; Palak & Walls, 2009). Valdez and his colleagues (2000) distinguished technology uses into three phases: Phase I of Print Automation, Phase II of Expansion of Learning Opportunities, and Phase III of Data-Driven Virtual Learning. In Phase I, "instruction was characterized by the use of behavioral-based branching software to teach segmented content and/skills" (p. 5). In Phase II, "computers became tools for learner-centered practices rather than content delivery systems, helping teachers move from largely isolated learning activities to applications that involve working in groups" (p.5). Phase III focuses on data-driven practices that "help facilitate effective learner-centered practices" (p. 25), and on data-driven decision making that "encompasses making systematic changes in curriculum, instruction, and assessment to the extent that it requires changes in student roles, teacher roles, and teaching and learning tasks and expectations" (p.25).

Technology uses in Phase I defined by Valdez and his colleagues coincide with low-level uses and tasks reported in technology integration research such as using computer for communication with colleagues or parents, or for rewarding and entertaining activities for students, asking students to finish homework assignments (e.g., writing reports, improving computer skills, searching information through Internet), and doing practiced drills with computers (Cuban, Kirkpatric, & Peck, 2001; Ertmer, 2005; Palak & Walls, 2009). These low-level technology uses are either tangential to learning tasks or against desired student-centered technology uses that "support inquiry, collaboration, or re-configured relationship among students and teachers" (Culp et al., 2005, p. 302).

2.2. Technology Integration: Barriers and Challenges

While the barrier related to limited access to technology resources has been largely removed today, low-level technology uses are still prevalent. One attributive factor identified is the lack of training in technology integration skills (Abrami, 2001; Cuban, et al., 2001; Hope, 1997; Zhao, 2007). Efforts have been made to prepare both pre-service and in-service teachers for technology integration. According to U.S. National Center of Education Statistics report (Wells & Lewis, 2006), 83% public schools offer professional development to their teachers to support technology integration. Teacher education programs are offering educational technology courses to enhance pre-service teachers' technology integration skills and, according to Hargrave and Hsu (2000), most teacher education programs in the U.S. offer at least one course in educational technology to their student teachers. However, when professional development is available, it is not uncommon for teachers to get training on technological skills of how to operate particular technologies or software rather than being informed of why and how to integrate them into instruction (Mishra & Koehler, 2006; Mueller, Wooda, Willoughby, Ross, & Specht, 2008). In teacher education programs, a single educational technology course disconnected from other method courses is still the dominant way of teaching technology integration in teacher preparation programs (Graham, Culatta, Pratt, & West, 2004; Mims, Polly, Shepherd, & Inan, 2006) and the focus of such educational technology course is mostly on technical skills rather than on how to use technology to create new opportunities for learning (Angeli & Valanides, 2009; Graham et al., 2004; Jimoyiannis, 2010). Underlying this standard approach of emphasizing technology rather than integration is a view that "unlocking the power and potential of technology can be achieved by acquiring basic competency with hardware and software packages" (Mishra & Koehler, 2006, p.1013).

Technology integration is not so much about technology or technological skills as about how technology can be used productively to realize effective teaching and learning. The success of technology integration relies on how well instruction is designed using appropriate technology (Earle, 2002). The barriers to technology integration are categorized into two types (Ertmer, 1999): first-order barriers and second-order barriers. While the first-order barriers, referred to by some researchers as environmental barriers (Mueller et al., 2008), include such barriers as equipments, time, and training which are extrinsic to teachers, the second-order barriers are related to teachers' beliefs about teaching and learning which are intrinsic and less tangible. It is argued that the first-order barriers are "easy to measure and relatively easy to eliminate" (Ertmer, 1999, p. 50). However, barriers related to technology integration trainings may not be easily removed unless the focus is on integration rather than technology. This task of training or preparing teachers for technology integration may be even harder than we have expected in face of the fact that we are dealing with moving targets (Valdez et al., 200) undergoing fast and constant upgrading and transformation, and creating the possibility of teachers' being "perpetual novices" in the technology integration process (Mueller et al., 2008).

As commented by Ertmer (1999), "Even if every first-order barrier were removed, teachers would not automatically use technology to achieve the kind of meaningful outcomes advocated" (p. 51). An important reason for this identified in literature is that teachers' beliefs underpin and exert great influence on their decisions and practices of technology uses (Ertmer, 1999, 2005; Hermans et al., 2008; Wang, Ertmer, & Newby, 2004). Technology integration research on teacher beliefs revolves around three main areas: attitudes toward technology and technology uses, self-efficacy, and pedagogical beliefs.

The attitudinal variables and their effects on technology integration practices investigated and revealed in previous research are multi-dimensional. Christensen' (2002) investigation of technology attitudes of 60 elementary school teachers showed that the fear among these teachers about their inability to stay ahead of their technology savvy students had a negative impact on their persistent use of technology in classrooms. In a study conducted by Mueller and her colleagues (2008) among 185 elementary and 204 secondary teachers, teachers' technology attitudes was investigated in terms of whether computer was perceived as a viable, productive, and cognitive tool to be used in the teaching context. The technology attitude defined as such was revealed in the study as a discriminating factor, at both elementary level and secondary level, distinguishing high integration from non-integration or limited integration. Teachers' technology attitudes was also approached in light of task values (i.e., interest, utility, and importance) a teacher perceives about technology integration and it was reported that the higher values perceived, the higher commitment teachers may hold for technology integration (Lin & Lu, 2010).

Another domain in the research of teacher beliefs about technology integration centers on teachers' self-efficacy beliefs. While self-efficacy in general is described as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3), it is referred to, in the specific technology integration context, as teachers' beliefs in their capacity to work effectively with technology (Wang et al., 2004). Research (Albion, 1999; Lin & Lu, 2010; Mueller, 2008; Piper, 2003; Wang et al., 2004) has been conducted to investigate how teachers' self-efficacy beliefs are related to technology uses. Findings from Piper's (2003) survey among 160 elementary and secondary teachers indicated that self-efficacy had great influence on classroom technology uses for those teachers who were novice-computer users. In Mueller el al.' s (2008) study, while teachers identified as high "integrators" demonstrated high self-efficacy beliefs about using computers as an instructional tool, low self-efficacy was associated with those identified as low "integrators." Self-efficacy beliefs about technology uses are also related to technology integration in such a way that higher perceived self-efficacy increases teachers' willingness to devote more time and effort to technology integration and consequently result in better technology integration practices (Lin & Lu, 2010). Empirical evidence from research on teachers' self-efficacy beliefs about technology uses may justify the conclusion that teachers' low self-efficacy beliefs or lack of confidence in using and working with technology will become a barrier impeding effective integration of technology into teaching and learning.

Like teachers' self-efficacy beliefs, teachers' pedagogical beliefs are identified in literature as a factor that may stand in the way of effective technology integration. Student-centered or constructivist pedagogical belief and traditional teacher-centered pedagogical belief have been investigated theoretically or empirically in previous research to reveal their impact on technology integration (Ertmer, 2005; Koç, 2005; Hermans et al., 2008; Liu, 2011). It is suggested that teachers' pedagogical beliefs are related to how technology is used (Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010). Empirical evidence supporting this can be found in a study conducted by Hermans and his colleagues (Hermans et al., 2008) among 525 primary school teachers. Findings from the study were "in line with earlier research suggesting that teachers with a strong constructivist orientation are more prone to adopting tools that foster constructivist learning approaches" (p1506), and it was reported in the study that "traditional teacher beliefs seem to have a negative impact on the integrated classroom use of computers" (p. 1506).

In a survey study (Niederhauser & Stoddart, 2001) conducted among 1093 elementary teachers in a western U.S. state well-recognized for leadership in educational technology, the relationship between teachers pedagogical beliefs and their choices of instructional software was investigated. The survey results from the study showed that "teachers who only used open-ended software had a strong learner-centered orientation and a weak computer-directed orientation, while teachers who used only skill-based software had the strongest computer-directed and lowest learner-centered orientations" (p.27). If we can argue, based on empirical evidence, teachers' pedagogical beliefs about teaching and learning are strong predictors of ways or patterns of technology integration practices, it is reasonable to believe that achieving effective technology integration and removing barriers related with traditional pedagogical beliefs can mandate changes in teachers' pedagogical belief system.

2.3. Technology Integration: Measurements and Measures

Along with findings from previous research regarding barriers and challenges for technology integration, a plethora of measures have been suggested by researchers to deal with these barriers and challenges. One of the measures worth mentioning is related to the TPACK model proposed by Mishra and Koehler (2006). According to them, the tendency in technology integration trainings and practices to focus on technology than how technology should be used can be "attributed to the lack of theoretical grounding for developing or understanding this process of integration" (p. 1018). The TPACK model was proposed as a measure against the "emphasis on what not how" tendency in technology integration training and practices. As a model about teacher knowledge essential for technology integration, the TPACK model emphasizes that "knowledge about content (C), pedagogy (P), and technology (T) is central for developing good teaching" (p.1025) and should not be treated as separate bodies of knowledge. The model reveals the interactions and connections between the three elements of content, pedagogy, and technology by defining seven domains of knowledge (i.e., TK: technology knowledge, PK: pedagogical knowledge, CK: content knowledge, PCK: pedagogical content knowledge, TCK: technological content knowledge, TPK: technological pedagogical knowledge, and TPCK: technological pedagogical content knowledge) and explaining the interplay between and among these domains of knowledge.

Mishra and Koehler (2006) developed the TPACK model based on their years of experiences of teaching educational technology courses using the learning technology by design approach. In this approach, the emphasis was rarely on direct instruction of particular software or technology. Instead, teachers were engaged in design-based activities requiring them to search and locate appropriate technologies and integrate them into instructional design by resolving contradictions and tensions resulting from content-, pedagogy-, and technology-related issues. It was reported by Mishra and Koehler (2006) that, although the emphasis of the learning technology by design approach is not on acquiring a pre-determined set of technology skills, "the list of technologies that were learned was impressive" (p.1037) during the learning by doing process. Theoretically, the TPACK model offers great insights about the dynamics between content, pedagogy, and technology, and highlights cultivation and development of TPCK as an important means of promoting integrated uses of technology in classrooms. Practically, the learning technology by design approach, both as an application and an empirical support to the TPACK model, points out an important technique that can be adopted in teacher preparation or professional development programs to prepare teachers for technology integration.

Like the TPACK model and the learning technology by design approach, many other suggestions or measures emerged from technology integration research concerning how to prepare teachers for effective technology integration. Some of these suggestions underscore the importance of effecting changes in teachers' self-efficacy beliefs about technology uses. In a study conducted by Wang, Ertmer, and Newby (2004), 408 pre-service teachers enrolled in an introductory educational technology course were randomly assigned to a control group or three experimental conditions: vicarious learning experiences involving watching videos on exemplary technology practices, goal setting involving evaluating technology-integrated activities based on goals received from the researchers, and both. The pre- and post-surveys measuring self-efficacy beliefs with the Computer Technology Integration Survey (CTIS) (Wang et al, 2004) instrument were administered to the participants. The results of the study indicated that both vicarious experiences and goal setting had significant positive effects on the participating pre-service teachers' judgments about their self-efficacy and such effects were greater among those who were exposed to both vicarious experiences and goal setting conditions. It was suggested in the study that "the use of electronic vicarious learning experiences and the incorporation of specific goals may help pre-service teachers develop the confidence they need to become effective technology users within their own classrooms" (p. 242). According to Ertmer (2005), the effects of vicarious experiences for teachers are bi-fold. Access to exemplary models of technology integration can provide teachers with information about how to use technology effectively, and identifying themselves with those similar and successful others, teachers may be able to build the confidence in their abilities of using technology. Modeling effect is an essential element in vicarious experiences. However, modeling effect does not have to be achieved only by observing model teachers and through electronic access to such teachers. Modeling of effective technology instruction by professors or instructors teaching method and/or educational technology courses are proposed as an effective way to prepare teachers for technology integration (Belland, 2009; Franklin & Molebash, 2007; Ward & Overall, 2011). In addition to having effective technology uses modeled to teachers, some researchers emphasize personal experiences as essential in teachers' learning about technology integration. Such personal experiences may involve field-based experiences for pre-service teachers (Ward & Overall, 2011) or technology uses by in-service teachers in their classrooms (Ertmer, 2005). These personal experiences, like the design experiences described by Mishra and Koehler (2006), emphasize learning by doing and encourage reflections as a means for improvement but are more situated and contextualized because technology uses are taking place in real classroom settings.

3. The EMPIRe Model: A Thinking Tool

The above measures proposed by researchers target different barriers and challenges of technology integration. The learning technology by design approach, embracing ideas advocated in the TPACK model, aims to prepare teachers for integrated uses of technology by allowing them to explore and understand through design-based activities the complex and dynamic relations between content, pedagogy, and technology. The vicarious experiences are viewed as promising in preparing teachers for technology integration by increasing teachers' self-efficacy beliefs and knowledge about how technology should be used. Teachers are expected to enhance their abilities to implement effective technology integration through personal experiences or by observing technology integration modeled to them. Characteristic of these measures is the expectation that teachers could be able to learn effective technology integration either by doing or by observing how others do. Are these measures capable of achieving the expected outcome?

In a study conducted by Archambault and Barnett (2010), a survey was administered to 596 online teachers employed at virtual schools across the United States to measure each of the knowledge domains defined in the TPACK framework. Results from the study indicated that "the highly accepted seven mutually exclusive domains of the TPACK theory may not exist in practice" (p. 1658), calling into question the clarity and precision of the TPACK model and its value in guiding teachers' thinking about technology. If the knowledge domains defined by the TPACK model is too vague and teachers have difficulties distinguishing them, it might not be reasonable to expect them to learn how to effectively integrate technology by exploring on their own the relationships between technology, content, and pedagogy as described in the learning technology by design approach. A model or framework able to provide teachers with more clear and specific guidance to their design of technology integration is needed.

It is argued that vicarious experiences have the potential of increasing teachers' self-efficacy beliefs. But, do enhanced self-efficacy beliefs entail technology integration? Even researchers engaged in research on teachers' self-efficacy beliefs admit that enhanced self-efficacy beliefs are a necessary condition but not a sufficient condition for technology integration (Wang et al., 2004). Belland (2009) criticized the reasoning underlying some technology integration research that "if teachers believe that technology should be integrated and that they can integrate technology, then technology integration will happen" (p. 354). He concluded, based on a review of studies on correlation between beliefs and behavior, that professed or perceived beliefs were not necessary predicators of behavior. If this is true, we may need to think about what needs to be done to make vicarious experiences more rewarding in the sense that such experiences could promote and facilitate technology integration.

3.1. The EMPIRe Model

Mayer (2004) noted that activities (e.g., hands-on activity and free exploration) may fail to help promote meaningful learning because learners may only be behaviorally active, but not cognitively active and that methods relying on doing should not be judged on how much doing is involved, but "on the degree to which they promote appropriate cognitive processing" (p.17). We expect that teachers would become willing to integrate technology and become capable of technology integration through activities of "learning by doing" (either through design activities or actual classroom technology integration practices) or by observing technology integration modeled to them. However, it might be possible that teachers are only behaviorally active instead of cognitively active in these activities. To engage teachers cognitively in these activities and to promote learning by thinking advocated by Mayer (2004) as genuine constructivist learning, the EMPIRe model (illustrated in Figure 1) is proposed here. The five important stages (i.e., Evaluating, Matching, Planning, Implementing, and

Reflection) in the EMPIRe model are an elaboration on the systematic process of technology integration discussed earlier in section 2.1 of this paper. The EMPIRe model draws upon the ADDIE model and set the five major instructional systems development processes (i.e., Analysis, Design, Development, Implementation, and Evaluation) in the context of instructional technology use.

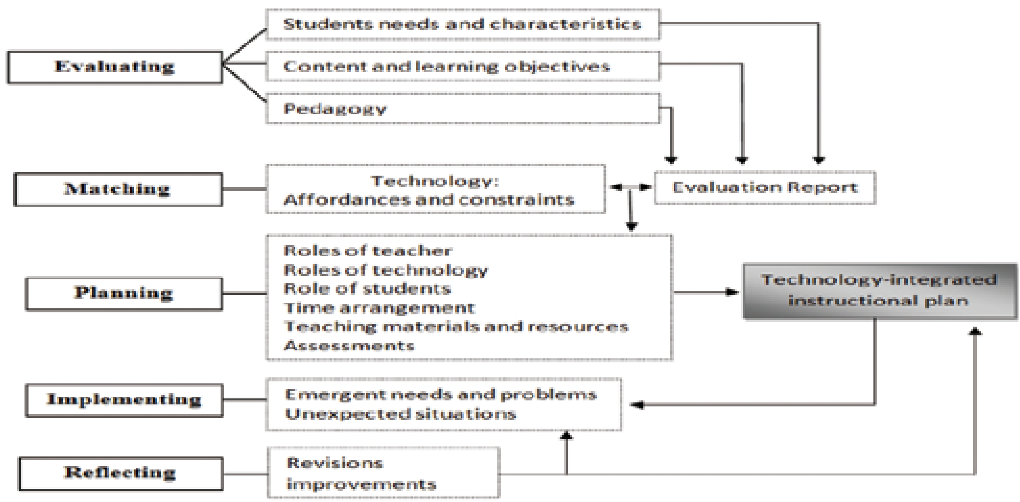

Figure 1: The EMPIRe model

The EMPIRe model is intended to be used both by teachers designing and implementing technology integration and by teachers observing technology integration being modeled to them. How this model can be used in these two situations is explained separately below.

3.1.1. Using the Empire Model for Design and Implementation Purpose

In the "Evaluating" stage, teachers make evaluation of the instructional tasks at hand and come up with a evaluation report, taking into consideration student needs and characteristics, content to be taught and learning objectives to be achieved, and possible pedagogy in terms of instructional strategies, methods, or activities that would help engage students, make content comprehensible, and promote critical thinking. In this stage, teachers do not need to worry about what and how technology should be used because thinking about technology at this stage would distract teachers from making a sound evaluation of the instructional tasks to be performed. At the "Matching" stage, teachers need to match particular technology with the evaluation report from the "Evaluation" stage. This matching process involves teachers' pedagogical reasoning that "integrates what they know about the subject, teaching, student, learning, and the technologies" (Niess, 2008, p. 231). Specifically, teachers first analyze particular technologies they have in mind that may be used in their instruction. The technology analysis can be either based on teachers' prior experiences with the technologies, or based on their investigation or vicarious knowledge about the technologies. With the analysis, teachers grasp a sound understanding about the technologies in terms of their affordances and constraints. Then, teachers match the affordances with things listed in the evaluation report (i.e., student needs and characteristics, content and learning objectives, and pedagogical choices and purposes). Decisions will be made about what technology or technologies are to be used on how well the affordances of the technology or technologies match the pedagogical choices and serve the pedagogical purposes.

The "Planning" stage is where teachers actually think about how the technology or technologies they have chosen should be used and come up with a detailed plan of technology-integrated instruction. To map out the plan, teachers need to think about: (a) the roles the teacher plays during the instructional process (e.g., content expert, facilitator, activity organizer, mediator between students and technology, and orchestrator of classroom performance);(b) the roles that technology plays (e.g., facilitating understanding about content related concepts or mastery of specific skills, engaging students, enhancing students motivation, promoting student collaboration and cooperation); (c) the roles students play (e.g., how students should participate in the learning process, how they should interact with teacher and technology); (d) specific time arrangement for instructional activities and for technology uses; (e) what specific assessments, both formative and summative, should be used to evaluate the learning results; and (e) what teaching materials or resources, including traditional and digital ones, are needed. Once the plan is worked out, teachers will move into the "Implementing" stage where they carry out the plan in their classrooms. In this stage, teachers may have to deal with emergent needs or problems and unexpected situations, and have to make corresponding changes to their original instruction plan. It would be advisable for teachers to take notes of those emergent or unexpected problems and situations, and to note down measures taken to deal with them. Such notes will largely substantiate the reflections in the stage that follows. In the final "Reflecting" stage, teachers refer to their notes and student assessment results and reflect on their technology-integrated instruction plan and the implementation process in terms of student responses and performances and the effects of technology uses. Based on their reflections, teacher may begin thinking about what revisions need to be made of the original instruction plan and what improvements need to be made of the implementation process. These reflections would help teachers enhance their competencies of making integrated use of technology in the long run.

3.1.2. Using the Empire Model When Observing Model Technology Integration

While the EMPIRe model can be used by teachers designing and implementing technology integrated instruction, it can also be used by teachers who observe and learn through technology integration modeled to them by successful others. In such case, the EMPIRe model will be used more as a tool guiding teachers' understanding or critique of what is modeled to them. Teachers can refer to the components included the "Evaluating" stage and come up with a clear picture, both in terms of students and content, about the instructional tasks involved in the modeled technology integration. When in the "Matching" stage, teachers are not supposed to do the actual matching as is needed for the design and implementation purpose. Instead, teachers critique the matching done by the model teacher, asking questions like "Is the technology chosen appropriate for the students?", "Does the technology chosen help engage the students?", and "Does the technology chosen serve the content and the teaching objectives?" Similarly, no actual planning take place in the "Planning" stage. Instead, teachers refer to the six components listed in this stage to understand how the technology integration planning is done by the model teacher. Then, teachers observe how the technology integration plan was implemented paying special attention to how the technology was used in the classroom, the students' responses and interactions with the technology, and how the model teachers dealt with problems or needs emerging during the instruction process. In the "Reflecting" stage, teachers reflect on the modeled technology integration they have observed and think about revisions or improvements that could be made.

3.2. The EMPIRe Model as a Thinking Tool

According to Shulman (1987), "teaching begins with an act of reason, continues with a process of reasoning, culminates in performances of imparting, eliciting, involving, or enticing, and is then thought about some more until the process begins again´(p. 13). Schulman's (1987) Pedagogical Reasoning and Action model well illustrates that teaching is largely a thinking process taking place in teachers' minds before and after actual classroom instruction, and the decisions resulting from the thinking process decide the effects of classroom instruction. When technology is added into the process, teachers' thinking about teaching is not only about content and pedagogy, but technology as well. If TPCK is essential for teachers' abilities to make integrated use of technology, perhaps it makes more sense to embrace TPCK not as a static knowledge base but as "a way of thinking strategically while involved in planning, organizing, critiquing, and abstracting, for specific content, specific student needs, and specific classroom situations while concurrently considering the multitude of twenty-first century technologies with the potential for supporting student learning" (Niess, 2008, p. 224). The EMPIRe model is intended to be used by teachers as a thinking tool guiding them to plan and organize their technology-integrated instruction strategically.

One aspect highlighted in the EMPIRe model is the pedagogical reasoning process. This process relies on teachers' prior pedagogical and technological knowledge they picked up in their previous teaching experience or as a teacher learner in teacher education programs. This pedagogical reasoning process culminates with the matching made by teachers between the technological affordances and the pedagogical purposes. Although it takes time for teachers to sharpen their pedagogical reasoning skills and become capable of using technology in transformative ways, it is motivating for teachers to realize that their prior pedagogical knowledge is valuable and technology integration, to some extent, means just using technology to achieve pedagogical purposes not able to be achieved by traditional means. For those teachers who learn through vicarious experiences or modeling, the EMPIRe model can be used as a thinking tool to help them make sense of and extract meaning out of the technology integration modeled to them. Moreover, the EMPIRe model is able to help these teachers organize the facts, concepts, and principles they gathered through vicarious experiences into well-structured mental models. These mental models would help promote teachers' understanding about the systematic process of technology integration and make them become better prepared for the ongoing challenges imposed by an ever-changing technological landscape. If vicarious experiences and technology integration modeling can help enhance teachers' self-efficacy beliefs, the EMPIRe model has the potential of pushing teachers a step further.

4. Conclusion

Although unremitting efforts have been devoted to preparing teachers for technology integration and physical resource barriers to technology integration have been largely removed, technology integration has occurred only minimally, both in terms of quality and quantity. Various barriers and challenges impeding technology integration have been identified in previous research and these barriers and challenges are standing in the way of preparing teachers for technology integration. Many different measures have been proposed by educational researchers to deal with these barriers and challenges.

The critical review in this paper of the proposed measures reveals the weaknesses and inadequacies of these measures in promoting teachers' learning of technology integration. The EMPIRe model is proposed as a thinking tool for facilitating teachers' learning of technology integration. Articulating the view that technology integration is a systematic process and a way of thinking, the EMPIRe model hopes to open a door toward the empire of technology integration by helping teachers not only learn by doing, but learn by thinking. The present paper is limited in the sense that the development of the EmPIRe model is literature review based. It is envisaged that future research will be conducted to provide empirical evidence regarding the effectiveness of the EMPIRe model in preparing teachers for technology integration and regarding effective applications of this model.

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