Two new insights into technology integration: The potential of instructional methods and type of technologies to enrich technology integration

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Abstract

The present paper reviews recent previous research conducted on technology integration as well as conceptual work done on the subject. As such, this paper focuses on factors that may promote or constrain successful technology integration into teaching practice. It reveals that there are many variables that may moderate the possible effects of technology integration on teaching and learning. These factors include but are not limited to teacher beliefs, technology access, teachers’ knowledge about technology integration and teachers’ self-efficacy of technology integration. Additionally, the purpose of the present paper is to suggest two other factors that may have contaminating effects on investigations on technology integration: type of technology depending on design purposes in relation to subject contents and instructional methods employed while integrating technology into teaching. Consequently, this paper provides a critical analysis of the previous research agenda and what warrants further research in addition to implications for practice of technology integration. Besides, it offers some evidence-based instructional methods or principles that may impact the process of technology integration. It concludes that research attempts aiming at investigating technology integration is as complicated as technology integration itself, which should be addressed by future research.

*Keywords:* technology integration, method, media , content, pedagogy

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Technology as a product has been developing quite rapidly since the beginning of the twentieth century (Saettler, 1990, cited in Reiser & Dempsey, 2007, p. 18) into the twenty-first century. Almost every new product found its own supporting circles in the area of education who enthusiastically claimed that the new medium would have ground-breaking effects on educational practice. Hew and Brush (2007, p. 224) stated that the technology as a potential education transformation and student improvement tool has grabbed educators’ attention. According to Hew and Brush (2007), this promise of technology has convinced most governments to initiate planned programs of technology integration and spare significant amounts of money to spend on it.

Although previous research pointed at potential benefits of technology integration in educational settings to a certain extent, most of it focused on external and internal factors or barriers and the relation between them (e.g., Ertmer, 1999). Closely related, some research focused on what teachers need to know (e.g., Koehler & Mishra, 2005) and the relationship between such variables as teachers’ self-efficacy perception and their technology integration practice (e.g., Nathan, 2009). Some other research, on the other hand, focused on the reasons why technology integration might not be happening (e.g., Bauer & Kenton, 2005). In addition to these insights, the purpose of the current paper is to review the recent previous research on technology integration, and identify instructional methods and type of technology as two possibly important factors that can foster practice of technology integration. In other words, it is suggested in the present paper that instructional methods employed during technology integration and type of technology may be highly relevant factors for successful integration of technology in that they may moderate the effects of technology, pedagogy and content. Finally, implications for future research and technology integration practice are provided.

**Technology Integration: What is it?**

Generally, researchers highlight the importance of technology integration in education because it can enhance learning. For instance, Clark (2006) stated that “Technology, in its many forms, has become a powerful tool to enhance curriculum and instruction” (p. 482). There are, on the other hand, some other researchers who hold a critical view of technology integration. According to McCabe and Skinner (2003), for instance, the connection between technology integration and greater student success is still indefinite (cited in Vitale, 2005, p. 16). Despite this, definitions of technology integration by different scholars appear to have a common focus point of enhancement of teaching and learning through integration of technology:

* “Integrated technology is technology that supports and enhances the achievement of specific teaching and learning goals.” (Yepes-Baraya, 2002, as cited in Peterman, 2003, p. 37).
* “…technology integration is more about teaching and learning than it is about technology.” (Mills & Tincher, 2002, p.2). Hence, the authors suggest that technology integration is more than using technological tools in the classrooms and requires teachers “be the technology!” (Mills & Tincher, 2002, p.2).
* According to Grabe and Grabe (2001) technology integration “focuses on technology-facilitated classroom activities that engage the thinking, decision-making, problem-solving, and reasoning behaviors of students” (cited in Vitale, 2005, p.9).

In line with the definitions above, according to Ertmer (1999), depending on the vision of technology integrators, (successful) technology integration may refer to the number of equipments available or the number of learning goals achieved (p.49). Ertmer (1999) further stated that instead of the amount of equipments or of time they are used, “…integration is better determined by observing the extent to which technology is used to facilitate teaching and learning” (p. 50). Likewise, Dede (2000) claimed that the important point is not having sophisticated technology or “availability” or “affordability” of it, but how it is used to promote learning or create fruitful learning experiences for learners (p. 299).

The definitions of technology integration given above also present a common challenge for what is understood of technology. As it is also accepted in the present paper, the focus on the enhancement of meaningful learning and practice of teaching through technology integration entails enlarging the borders of technology beyond what comes to most people’s minds when technology comes onto the stage: media, devices or tools. Seymour (1993) defines technology as the process of attempts “to expand human potential and to improve and control our world (as cited in Yıldırım, 2000, p. 479). It is, therefore, important to conceptualize integration of technology itself as a process consisting of not only technological equipments available but also the ways in which they are used to expand our learning potential.

**Instructional Methods and Type of Technology as Potential Factors Moderating Technology Integration**

To the best of the author’s knowledge and on the basis of the research reviewed in the current paper, none of the previous studies questioned type of technology to be integrated into teaching as an independent factor. That’s why they do not provide an answer to the question of “what would be the differences between integration of technology that is designed to learn or teach certain content and technology that is unrelated to the content but used to learn or teach it? Consequently, this paper suggests that type of technology may have a significant function in the facilitation of both teaching and learning. Given the fact that there are many types of technologies, this question is highly relevant since teachers may have access to different sorts of technologies not only to those specifically built up to teach or learn a specific subject matter. For instance, it is reasonable to assume that integration of a web 2.0 tool (e.g., VoxSwap) into an English class that is specifically designed for foreign or second language learning may present quite different challenges compared to a web 2.0 tool that is designed for social networking (e.g., Facebook). Accordingly, it is also reasonable to assume that the challenges will increase in number as the affordances or functional capabilities of different types of technologies diverges from certain content areas. As a result, it is assumed in the current paper that type of technology or design purposes behind technology may be highly relevant to the “integrability” of technology and specific content area.

In addition, the previous research does not provide insights into what kind of roles methods may play in successful integration of technology. In his discussion about whether the modality effect changes among different sorts of media, Moreno (2006) suggested that the beneficiary effects of bimodal presentation were the same across different media. Moreno (2006) was so careful not to claim that his results refer to triviality of media or technology since “different media may afford different instructional methods” (p. 156). It should be noted that the modality principle is one of the instructional design principles that can be followed during technology integration as well as some others. Hence, depending on whether technologies can afford certain types of methods or principles, beneficial effects of technology integration on teaching and learning can be moderated. To illustrate, Mayer (2001, p.134) claimed that presenting text corresponding to animation in an auditory format enhances learning better than presenting the text in a written form (i.e., the modality effect). However, while it would be possible for television to support the modality effect, it would not be so for the radio. Needless to say, interestingly enough, television can also present written text and together with corresponding animation. For these reasons, it is also assumed in this paper that although it is important that teachers should have technology knowledge (e.g., which technology can afford which instructional method), teachers’ knowledge of instructional methods or principles may finally determine whether they will integrate more established instructional methods in their teaching through technology integration.

As a result, the purpose of the current paper is to propose that type of technology (specifically designed for any subject content versus designed for some purposes other than education) and instructional method or principle implemented through technology may function as two important factors that affect successful technology integration. It should be noticed that these two factors appear to be closely related in increasing the chances that technology integration will not be limited to technology itself but expand on facilitating teaching and learning, which is totally in line with the definition of technology found in the literature. Needless to say, the current paper also assumes that these two factors are closely related not only to teacher knowledge for technology integration but also to other factors diagnosed as impacting technology integration by previous research. After all, in order to successfully integrate a specific technology, it seems that teachers need to know type or aspects of that technology as well as knowing instructional methods so as to figure out how to present or deliver instruction to learners effectively. Moreover, such type of knowledge may proactively prevent loss of time later on during the practice when some problems related to type of technology and method pop up, thus also contributing to the efficiency of the practice. Consequently, these two appear to be effective candidates that serve facilitation of teaching and learning practice to a certain extent.

In what follows, the current paper firstly summarizes the previous research done on technology integration in order to figure out (a) Possible benefits of technology; (b) The factors that promote and constrain technology integration; (c) The scope of teachers’ knowledge about technology integration; (d) The effects of instructional methods compared to media effects. The second section presents a critical analysis of previous research and perspectives taken in the current paper as well as implications for further research and development. Overall, the current paper questions “type of technology and instructional methods” in terms of (a) contributing to the discovered benefits of technology integration; (b) relating to factors that promote and those that constrain technology integration; (c) relating to teacher knowledge for effective technology integration; (d) relating to technology affordance.

**What Does Recent Previous Research Say about Technology Integration?**

The present part of the paper attempts to answer the following questions:

* What has been found about the benefits of technology integration?
* What factors enhance and what factors constrain technology integration?
* What should teachers know in order to achieve successful technology integration?
* Are the effects of methods and media on learning differentiable from one another?

Under certain conditions, it has been shown that technology can promote student learning in terms of quantity, rate, motivation and more connections to the community and outside world (Lemke & Coughlin, 1998; Niederhauser, Lindstrom, & Strobel, 2007; Schacter & Fagnano, 1999, cited in Kuker, 2009, p. 14). Needless to say, the positive effects of technology integration increased the number of scientific studies conducted to better understand how technology integration increases learning as well as the factors that promote or impede successful technology integration. The following section questions whether technology integration is beneficial and if so, to what extent.

**To what extent is technology integration beneficial?**

There has been a debate over whether integration of technology is beneficial in that it instigates student achievement. While some researchers have been on or not on the side of technology integration, some others pointed out both positive and negative findings including some inconclusive ones. According to Sherry and Jesse (2000), technology helps to engage students more in the learning process by also helping them develop skills and increase their motivation (Documenting the impact of technology in the classroom section, para. 1).

After reviewing five large-scale studies, in 1999, Schacter concluded in his report that under technology integration students “show positive gains in achievement on researcher constructed tests, standardizes tests, and national tests.” (p. 9). However, despite the optimistic conclusion of Schacter (1999)[[1]](#footnote-1), some research studies he reviewed pointed at negative as well as inconclusive results regarding the benefits of technology integration. For instance, Kulik’s (1994) meta-analyses yielded that despite certain advantages, computers did not lead to positive results in every subject area in which they were integrated (cited in Schacter, 1999, p. 4). Although similarly highlighting the positive effects of technology integration, Sivin-Kachala’s (1998) literature review also pointed out that inconclusive results of technology integration can be reached because of: “the specific student population, the software design, the educator’s role, and the level of student access to the technology.” (cited in Schacter, 1999, p. 5). As for possible negative effects, Wenglinsky (1998) revealed that both fourth and eighth graders who engaged in drill and practice technology performed more poorly in the national assessment of educational progress than the students who did not use that technology (cited in Schacter, 1999, p.8).

Moreover, after reflecting upon 311 reports and reviews of technology integration, Ringstaff and Kelley (2002) reported that technology may positively affect and change learners’ attitudes toward “learning self-confidence, and self-esteem”. (cited in Redditt, 2007, p. 19). Likewise, it was suggested that technology has the potential to increase student achievement in subject areas including math (e.g., Archer, 1998; Mehlinger, 1997, cited in Redditt, 2007, p. 20). However, Roblyer (2003) argued that research has not been able to show strong positive effects of technology integration on teaching and learning (cited in Redditt, 2007, p. 18).

In summary, previous research points out that technology integration may have positive impacts on learners’ motivational level and attitudes toward learning in general, which increases achievement under certain conditions. It should be remembered once more that the literature reviewed above also states that benefits of technology integration can be quite limited depending on teacher beliefs, specific subject areas and method or techniques (e.g., drill and practice) through which technology is used in the classroom.

**Factors Promoting and Constraining Technology Integration**

McKenzie (2000) asserted that the continuous and rapid technological developments and the need for a skilled workforce that can keep pace with it have had direct impacts on school practices (Harvey-Buschel, 2009, p. 22). Similarly, Heflich (1998) suggested that schools need to be “technologically competent” in order to survive global competitiveness (cited in Harvey-Buschel, 2009, p. 22). Therefore, it is safe to argue that technology integration has become an essential component for schools to prove themselves effective learning resources. However, as highlighted above, technology integration is not necessarily beneficial. This, inevitably, makes it necessary to decipher both the factors that enhance technology integration and those that constrain it.

**Factors that may enhance technology integration.**

Cuthell (2006) showed a strong relationship between learner engagement and computer technology use in the class (cited in Harvey-Buschel, 2009, p. 38). Likewise, Harvey-Busche (2009) also cited Solomon’s (1998) study revealing a significant and positive correlation between time spent on using computers, learner engagement and increased understanding of the content (p. 38). Roshelle, Pea, Hoadley, Gordin and Means (2000, p. 5) identified several factors that impact how technology integration would promote learning. These are (a) active engagement; (b) participation in groups; (c) frequent interaction and feedback; (d) connections to real-world contexts.

Accepting criticisms on beneficial effects of technology integration on teaching and learning, Norris, Sullivan, Poirot and Soloway (2003) claimed that lack of access to technology moderates lack of technology impact (p. 11). The researchers stated that “If students do not have access to classroom computers, then classroom computers can’t possible have a measurable impact on students’ learning!” (p. 11). Through correspondence analysis, Norris, Sullivan, Poirot and Soloway (2003) reached a strong relationship between computer access and their use in the classroom (p. 9). Similarly, a survey study conducted by Leonard and Leonard (2006) with school principals and assistant principals showed that teachers in their schools were not happy with the amount of access to technology (p. 217). Accordingly, access was one of the biggest barriers to technology integration in their schools. In the same line of logic, Heflich (2006) showed that level of access to technology in classrooms directly affects the extent to which the technological resources are used in the classroom (cited in Harvey-Busche, 2009, p. 36).

**Factors that may impede technology integration.**

Roshelle, Pea, Hoadley, Gordin, Means (2000) stated that the real challenge for technology integration is to make it sure that it is used effectively to promote learning (p. 25). The researchers implied that lack of “technology access and technical support, instructional vision, a critical mass of teachers in technology activities, collaboration among teachers, strong leaders, support for teacher time for planning, collaboration, and reporting technology use” may affect technology integration negatively (p. 24). Likewise, Ertmer (1999) highlighted that lack of a well-grounded vision for technology integration is one of the important barriers to it since vision brings up a sort of awareness about “what is central to our technology efforts” (p. 54). In addition, she highlighted “access, time, training” and “support” as possible strategies to address resource limitations whose absence constitutes constraints to successful technology integration (p. 56).

More specifically speaking, Ertmer (1999) divided barriers to technology integration into first-order/external and second-order/internal barriers (p. 47). Means and Olson (1997) described the former barriers as absence or insufficient supply of resources including equipment, time, training, and support (cited in Ertmer, 1999, p. 50). According to Ertmer (1999), second-order or internal barriers rest upon teachers’ personal beliefs about teaching and learning (p. 51). She further suggested that because internal barriers are less concrete than external barriers they may become more problematic (p. 50). As for any possible interactions between external and internal barriers, Ertmer (1999, p. 53) asserted that the power of the latter barriers may moderate the effect of the former barriers that can be significant constraints to technology integration. More recently, Ertmer (2005) contended that if teacher’s technology integration that enhances learning is to be achieved, how teachers’ teaching practices are affected by their pedagogical beliefs should be considered (p. 36).

Wallace, Kupperman, Krajcik and Soloway (2000) identified “time management”, “student productivity”, and “focus” as challenges that can be confronted during technology integration (p. 39). In addition to such possible constraints to technology integration, Verdugo and Belmonte (2007) yielded other possible obstacles such as ineffective user interface, lack of support from other people (e.g., experts) with more technology knowledge. Moreover, Leonard and Leonard (2006) identified lack of strong leadership on the part of school principals and assistant principals as one of the drawbacks to successful integration of technology for educational purposes (p. 213).

**The scope of teacher knowledge for successful technology integration.**

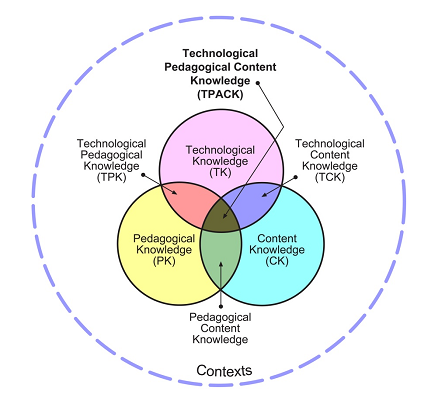
Shulman (1987) pinpointed that teachers should be able to help their students to the extent that they master the domain knowledge being taught (cited in Roshelle, Pea, Hoadley, Gordin, & Means, 2000, p. 21). Similarly, Roshelle, Pea, Hoadley, Gordin and Means (2000, p. 21) maintained that “Teaching with technology is no different in this regard”. Technology, pedagogy and content knowledge (TPACK) framework (Koehler & Mishra, 2009; Koehler & Mishra, 2008; Mishra & Koehler, 2006) provides a detailed analysis of what kind of knowledge teachers should bring to the classroom in order to integrate technology successfully. The section below provides an overview of TPACK:

***Technology, pedagogy and content knowledge (TPACK).***

Shulman (1986), and Wilson, Shulman and Richert (1987) proposed pedagogical-content knowledge as a subpart of content knowledge (cited in Pierson, 1999, p. 224). In her 1999 doctoral dissertation, Pierson went one step further and suggested the addition of technological knowledge to pedagogical-content knowledge, thus coining “technological-pedagogical-content knowledge” (p. 224). She stated that, for effective technology integration, teachers should combine technological knowledge with content and pedagogical knowledge (p. 224).

Through extensive work (e.g., Koehler & Mishra, 2008; Mishra & Koehler, 2006), Koehler and Mishra managed to develop a detailed theoretical framework called TPACK that identifies relationships existing between and among TPACK knowledge components: technology, pedagogy and content. Mishra and Koehler (2006) stressed that teaching itself is an ill-structured complex activity that requires teachers have a lot types of knowledge (p. 1020). Consequently, Mishra and Koehler expanded Shulman’s (1986) pedagogical content knowledge and added technological knowledge to the combination, which has become known as TPACK (Mishra & Koehler, 2006, p. 1025; Koehler and Mishra, 2008, p. 3). The main point of the researchers is that teachers need to have knowledge about content, pedagogy, technology as well as the interrelationships among and between them to enhance effective learning. Furthermore, by pointing to teacher pedagogical beliefs as a possible source of barriers to higher level technology integration, Ertmer (2005, p. 29) suggested that teachers’ “more central beliefs” may affect teaching with technology. This implies that teachers’ existing beliefs may moderate not only their teaching with technology practice but also their acquisition of TPACK knowledge

Mishra and Koehler (2006, p. 1026) already acknowledged that the idea of TPACK is not entirely new in that some researchers contended that technology knowledge should not be regarded as separate from pedagogy and content (e.g., Hughes, 2005; Keating & Evans, 2001; Neiss, 2005, cited in Mishra & Koehler, 2006, p. 1026). Figure 1 below depicts the TPACK framework symbolically:



*Figure 1.* TPACK and its components (taken from Koehler & Mishra, 2009, p. 63)

Figure 1 above shows the interconnections between and among three important knowledge components of TPACK: technology, pedagogy and content. Content knowledge directly refers to a teacher’s knowledge about the content of the subject matter that they teach (Mishra & Koehler, 2006, p. 1026). Pedagogical knowledge is teacher’s knowledge about the how learning happens effectively and how teaching contributes to it. In other words, it includes “processes and practices or methods of teaching and learning” as well as teachers’ “overall educational purposes, values, and aims” (Koehler & Mishra, 2008, p. 14).

Pedagogical content knowledge is in line with Shulman’s (1986) ideas about pedagogical knowledge tailored to specific content and it covers knowledge of pedagogy that can be employed to teach a particular content (Koehler & Mishra, 2009, p. 64). Arguing that technology knowledge is something ever-evolving, Koehler and Mishra (2009) described it as continuous attempts of teachers to know about how particular technologies can or cannot be used in certain ways to trigger meaningful learning (p. 64). To put it in a different way, according to Koehler and Mishra (2009, p. 64), technology knowledge exceeds having pure knowledge of technology and includes updating that knowledge and how to use it effectively and continuously. Technology content knowledge is the understanding of how technology and content can affect and limit each other (Koehler & Mishra, 2008, p. 16). Namely, technology content knowledge requires teachers be knowledgeable about how specific type of technologies can address learning issues in their subject matter and how their subject matter may entail use of those technologies (Koehler & Mishra, 2009, p. 65). Technological pedagogical knowledge is knowledge about how the use of particular types of technologies can interact with certain types of teaching and learning processes (Mishra & Koehler, 2006, p. 1028). Finally, technology, pedagogy and content knowledge is an understanding of the interrelationships that exist among not only technology, pedagogy and content but also among their intersections (Koehler & Mishra, 2009, p. 66). In other words, it is both the deeper and umbrella knowledge of how to combine all knowledge components in a coherent way to encourage effective learning. Therefore, it includes knowledge bases that range from “pedagogical techniques that use technologies in constructive ways to teach content” to “knowledge of students’ prior knowledge and theories of epistemology” (Mishra & Koehler, 2006, p. 1029).

It should be noticed that TPACK does not regard technology as an artificial suffix to the whole teaching and learning process but sees it as an integral part of it. This way, technology is connected to the other two important parts of any teaching and learning context: pedagogy and content. In addition, it is not the pure total of technology, pedagogy and content but it is more than that total, which includes interconnections “between and among the three components” (Koehler & Mishra, 2009, p. 62).

**Corresponding roles of methods and media in learning**

Clark (1999) claimed that what matters for learning are instructional methods implemented through technological media and that so long as these methods enhance learning, media used are of no importance (cited in Moreno, 2006, p. 152). In an earlier article, Clark (1983) also challenged the studies on effects of different types of media on learning by stating that “media do not influence learning under any conditions” (p. 445). Clark (1983) further claimed that the evidence for effects of media on learning may be attributed to “the uncontrolled effects of novelty and instructional method” (p. 447). Likewise, Mielke (1968) revealed that no matter what type of media whose effect on learning was investigated, studies comparing different media effects ended up with no significant difference (cited in Clark, 1983, p. 447). On the other hand, claiming that Clark`s (1983) emphasis on methods not media leads to “an unnecessary schism between medium and method”, Kozma (1991, p. 205) asserted that the two have a mutual relationship. Kozma (1991) further claimed that medium has the power to render the method possible or not while the method rests upon and instigates the functional capabilities or affordances of the medium (p. 205). The present paper takes an approach closer to that of Kozma (1991) in that even though methods employed may have considerable effects on successful technology integration, different technologies may support methods in different ways. This is also one of the reasons why type of technology is also hypothesized to play an important role in technology integration.

Interestingly enough, Kulik, Kulik, and Cohen (1980) pointed out that the suggested effects of media on learning disappear to a certain extent when the same teacher delivers all the treatment in a study (cited in Clark, 1983, p. 448). Mielke (1968) proposed that only types of media that are compared should be different in media comparison studies while all other parts of the treatment including “the subject matter content and method of instruction” are the same (cited in Clark, 1983, p. 448). Consequently, Clark (1983) argued that because media effect disappears when the same instructor delivers the instruction, it is reasonable to argue that some contaminating factors including novelty of content and instructional method moderate media effect, if any (p. 448).

Furthermore, Clark (1983) contended that there could also be effects of novelty with new media on research participants’ performance (p. 450). Kulik, Bangert, and Williams’ (1983) review included supportive evidence for this hypothesis in that the average effect size for computerized instruction decreased significantly in studies with longer durations (cited in Clark, 1983, p. 450). Clark (1983) attributed this phenomenon to the increased effort and attention of research participants at the beginning (p. 450). Clark (1983) concluded that fruitful conditions for learning should be reflected upon thoroughly and attributes or capabilities of media such as zooming may instigate learning enhancement more than media themselves (p. 453).

Moreno (2006) is a recent example of research that tested method versus medium affect learning hypotheses. Moreover, she focused on one of the most recently suggested instructional methods: the modality effect (Mayer, 2001, p. 134). Moreno (2006) examined whether there is a possible interaction between the modality principle and type of media used to determine whether different media can moderate the modality principle. She used three types of media: “desktop multimedia explanations, agent-based multimedia games” and “virtual reality environments” (p. 152). Results of participant performance on both retention and transfer tests revealed only a significant effect of the modality principle excluding main effect of media and any combined effect of the modality principle and media (p. 153). In addition, citing Ginns’ (2005) meta-analysis of the modality principle, Moreno (2006) further claimed that as long as learning material has high element interactivity and instruction is system paced, the modality principle holds true across not only different media but different subject domains (p. 154). However, Moreno (2006) also emphasized that since different media can support different instructional methods, functional capabilities of media should be kept in mind before concluding about effectiveness of media (p. 156).

To sum up, previous research shows that instructional method that can be employed by a particular type of media may have stronger effects than the media themselves on learning. On the other hand, different media have different affordances that may enable or constrain instructional methods. Hence, functional capabilities or affordances of media should also be paid attention. All these factors seem to be directly relevant to technology integration in that it includes the implementation of instructional methods through the use of media.

**More Critical Insights and Implications for Future Research and Practice**

Previous research reviewed in the present paper suggests that generally researchers tend to differentiate between technology integration and simple use of technological devices or media except for media comparison studies. In addition, researchers seem to have reached a consensus on the definition of technology integration especially in that technology integration serves effective learning. In other words, technology integration has been conceptualized as a way of instigating enhancement of both teaching and learning (e.g., Mills & Tincher, 2002). This understanding of technology integration, I think, is crucial to differentiate between utilization and integration of technology. Utilization of technology may be stated as the simple use of technological tools or media to deliver instruction whereas technology integration requires a more thorough reflection on how to contextualize both the content to teach and resources available which includes technology into a meaningful learning environment. To put it in another way, technology should not be simply used just for the sake of it, but it should be integrated into any learning context to achieve certain educational or pedagogical purposes. I think this further means that teachers should reflect upon not only technological resources in hand but also on the content they teach and their pedagogical purposes. This argument is totally in line with TPACK framework (Koehler & Mishra, 2008; Koehler & Mishra, 2009; Mishra & Koehler, 2006) that emphasizes three core knowledge components (technology, content, and pedagogy) as well as the interrelationships between and among them. Therefore, it is reasonable to claim that TPACK does not isolate technology as a set of isolated devices but as a resource to be integrated with content and pedagogy.

Likewise, it is not surprising that previous research also suggests that teachers’ beliefs including pedagogical and self-efficacy ones are of great importance for successful technology integration (e.g., Ertmer, 1999; Ertmer, 2005; Ertmer et al. 2003). For instance, Ertmer et al. (2003) stated that having optimistic or “best ideas about technology” is not enough unless teachers have a certain belief that they can integrate them into their teaching (p. 97). Similarly, Ertmer (2005) asserted that if we wish to change teachers’ practice in terms of technology integration, teachers’ pedagogical beliefs should be addressed, but not ignored (p. 36). It seems to be also important to keep any possible interactions or relationships between teachers’ beliefs or self-efficacy perceptions and their knowledge about technology integration (Nathan, 2009, p. 64). I think that what all these studies suggest is compatible with TPACK since teacher beliefs may function as an important catalyst for teachers’ development of their knowledge bases and interconnections among them as specified by TPACK. To illustrate, teachers’ pedagogical beliefs may moderate their attempts to bridge their technology, content and pedagogy knowledge bases by affecting for what purposes they would teach their subject matter through integration of technology. After all, teachers’ beliefs may also make it clear whether they are willing to integrate technology into their practice or not at the very beginning.

Moreover, most of the previous research addressed in this paper focuses on how to integrate technology in either general sense (e.g., Bauer & Kenton, 2005; Dede, 2000) or technology tailored to teach a specific content (e.g., Harvey-Buschel, 2009). Consequently, previous research agenda does not seem to examine any possible differences or challenges in integration of technology in the following two ways: (a) technology that is unrelated to subject content but integrated to teach it; (b) technology that is purposefully designed to teach a specific content. I think that such an approach would be provide more insights into how teachers deal and should deal with different types of technology when they are willing to integrate it into their teaching. More specifically speaking, all other factors covered in this paper being equal, comparing integration of general technology to that of specifically designed technology may reveal different sorts of potential challenges for teachers. In a world where new technologies show up frequently, knowing those challenges may be fruitful for developing some working strategies for teachers to cope with them.

Not only type of technology but instructional methods employed through technology may function as a contaminating factor for future research as suggested by Clark (1983, p. 447). Moreno’s (2006) comparison of the modality effect among three different types of technology and Ginns’ (2005) meta-analysis of it (cited in Moreno, 2006, p. 154) supports Clark’s argument. The suggestion that methods should be paid attention to in technology integration is also in harmony with Ertmer’s (1999) argument that the focus should be on “what we do with technology rather than on the kinds of equipments with which we do it” (p. 49). However, as highlighted by Kozma (1991), the possible role of the medium as a catalyst on effects of instructional methods employed should not be disregarded. I think that instructional methods certain types of technology can afford may affect what teachers can do with technological media and how they integrate technology in the classroom. Therefore, it is reasonable to suggest that further research seeking the effects of certain types of instructional methods during technology integration is warranted. Moreover, future research on technology integration should be aware of possible confounding effects of methods involved in technology and should try to control for them by including methods as constants. However, as Moreno (2006, p. 156) highlighted, it is also important to reflect upon to what extent technologies can functionally afford different types of instructional methods.

One might also question where to place methods in the general framework of TPACK. I would argue that they are at the hearth of TPACK: they are a part of the intersection of three knowledge bases of technology, content, and pedagogy. There are some reasons for such a claim: (a) Different technologies have different functional capabilities that can support different types of instructional methods. For instance, an overhead projector cannot support multimodal (i.e., the modality principle) presentation of learning materials while a computer does. It might be argued that a teacher can provide the auditory material through speaking while using an overhead projector to present the material. However, it should be noticed that the tiny detail here is that the auditory instruction does not belong to the projector but the teacher. (b) Instructional methods are also directly linked to pedagogy and content as well in that they are about how to teach and learn some information content. To illustrate, to decide how to teach an expository history text (simple text, text with corresponding illustrations or animations with auditory instruction) requires knowledge of both multimedia and modality principles and how they can facilitate learning compared to a text-only presentation. After all, it may be important to know how each knowledge component of TPACK interacts with instructional methods or how these components and methods constrain one another.

As a result, here, I would like to suggest that success of technology integration may be moderated by the type of technology in question and the instructional method employed through the technology. This suggestion also incorporates the idea that due to divergent affordances or functional capabilities, different media may impact successful technology integration by either enabling or disabling methods. Inevitably, all these require teachers become aware of the issues covered so far while integrating technology into their teaching. Needless to say, how such knowledge can be constructed and incorporated into existing theoretical base (e.g.; TPACK) and how it can be applied successfully in real-life teaching practice entail further research. It is also suggested here that future research may choose to focus on instructional methods that have evidence-based support behind them. Cognitive load theory (Sweller, 1988) and cognitive theory of multimedia learning (Mayer, 2001) have already identified some overlapping methods that may facilitate technology integration. Mayer`s (2001) cognitive theory of multimedia learning includes the following methods or principles that may contribute to technology integration as long as they are supported by the functional affordances of the particular media in question:

* Multimedia principle: Better learning occurs when learners attend to both words and pictures simultaneously than words alone. The theoretical rationale is that when presented with both words and pictures, learners are more likely to build up verbal and pictorial models and make connections between them.
* Spatial contiguity principle: There is better learning when learners receive written words and corresponding pictures that are presented near each other rather than far from each other. The rationale is that when pictures and words are near to one another, they can be more easily held and processed at the same time, thus not having to use more cognitive resources to search for relevant material.
* Temporal contiguity principle: When auditory words and corresponding pictures are presented simultaneously rather than successively, people learn better. If the words and pictures are presented at the same time, learners are more likely to be able to process mental representations of both simultaneously. Moreover, when words and corresponding pictures are presented simultaneously, they are more likely to be integrated into pictorial and verbal mental models and learners are more likely to be able to make connections between them.
* Coherence principle: Multimedia instructional materials lead to better learning when extraneous information sources (e.g., irrelevant, unnecessary pictures, no matter how interesting they may look) are excluded than included. This depends on the assumption that extraneous information competes for limited cognitive resources.
* Modality principle: Better learning occurs, when words are presented in an auditory form rather than visual form. For instance, people learn better from narrated text with pictures than from text with pictures, because both auditory and visual channels are used rather than only the visual channel which would be overloaded by both words and pictures.
* Redundancy principle: There is better learning when redundant information is excluded since redundant information competes for already limited working memory resources, thus increasing cognitive load. In other words, the same verbal information should not be delivered both aurally and visually.
* Individual differences: Individual differences among learners in terms of prior knowledge and spatial ability may moderate the level of learning they accomplish in technology-based learning environments. As an example, some instructional methods may work for novice learners while they may not work for expert learners.

Needless to say, it is further suggested that teachers have knowledge of these methods as well as what media can afford them to what extent in order to construct more effective learning environments in their teaching practice.

In conclusion, technology appears to contribute to the complicated nature of teaching. That is why it is safe to conclude that teaching with technology is a delicate enterprise that requires teachers be knowledgeable about technology, content and pedagogy, and the relationships between and among them. Unsurprisingly, research on technology integration is an equally complex endeavor that should deal with a lot of factors ranging from technology access to teacher beliefs. The current paper added type of technology (tailored to teaching a certain content area or not) and instructional methods to the research agenda, which warrants further research.

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1. This study was conducted for and sponsored by Miken Family Foundation. Hence, the reader is suggested to look for “Miken Family Foundation (1999)” in the references section to see the whole reference for the study. [↑](#footnote-ref-1)