Can Technology Be a Transformative Force in Education?

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The interactive relation between technology and stakeholders creates the framework for a changing classroom culture using technology. Factors that influence a system’s transformation include philosophy, stakeholders, access, and goals. A wise choice for the use of technology and best practices for teaching and learning permits a sustained transformation of educational systems that focus on improving student performance.

Keywords: change, teaching practice, technology, technology integration, transformation

Various forms of technology have long been used to enhance teaching and learning experiences and processes, supported by the assumption that technology can play a role in influencing economic and social development (Dutta & Bilbao-Osorio, 2012). From a historical perspective, technology can be as simple as a pencil, chalk, or a blackboard. In the middle of the 20th century, multiple types of technologies, such as calculators, television, and projectors (overheads, film strip, and movie) were integrated into schools. The types of technologies available in the latter part of the 20th century included computers, pocket personal computers, laptops, digital cameras, laser disc players, audio-video manipulation equipment, and smart boards. In the early 21st century, it is forecasted that computers and mobile devices such as tablets, laptops, and phones will become the most popular and widely disseminated forms of electronic technology used in public schools.

Mobile devices, or small computer products used for a variety of purposes, include personal digital assistants, cell phones, smartphones (e.g., iPhone, Androids), tablets (e.g., iPad, Touchpad, IdeaPad), netbooks, or any other computing device that can be held by hand and have enough battery power to work without constant connection to an electrical outlet (Kukulska-Hulme & Traxler, 2005). These devices helped to build demand for a technology system in which access would be widespread and provide the opportunity to integrate technology into teaching and learning in new ways (Karrer, 2011). The Internet access made available through these devices enables teachers and students to access and use cloud computing resources, such as those associated with storing files and documents, or using applications not available on the device (PC Mag, 2009). Cloud computing opens the technology world to users who do not have devices with large storage capacities associated with internal organizational servers that typically would be used to store computer programs, or applications and documents; cloud computing offers students, teachers, and administrators access to a wide range of technology options.

On a global level, many schools may lack the basics of electricity or building infrastructure and the teaching staff may not have the skills needed to integrate technology into classroom environments. However, regardless of the setting, the purpose and role of technology in education and how to effectively and efficiently integrate technology into classrooms is an important issue. As technology proliferates to all parts of the world, it is viewed as an agent of change; stakeholders in education such as teachers, administrators, parents, and politicians are interested in the effective integration of technology in the classroom (Keengwe, 2007). This interest, however, and the effect such technology could have on the fabric of society, has been questioned. Concerns are being raised regarding the economic cost of implementing and maintaining the infrastructure necessary to sustain the integration of technology into classroom regardless of location (Dutta & Bilbao-Osorio, 2012).

The use of technology must be viewed through the pragmatic lens of environmental and structural contexts. Issues to be considered might include infrastructure, funding resources, proposed use for hardware/software, and professional development. Depending on the situation, an overall limited familiarity with the technology and potential methods for the integration of that technology into the curriculum may be of concern to educators. The many facets of using technology in the curriculum illustrate the critical importance of, and reasons for, training related to the integration of technology in a cultural context. While embodying a culture of its own, technology has the ability to transform a system’s culture, especially when embraced by the stakeholders in the system. However, inconsistent and improper introduction of technology into a system may result in the failure to
successfully use and integrate technology into teaching and learning environments.

Through international aid programs and other initiatives, technologies have been introduced in developing countries and, in some cases, have created unexpected problems in the local community, especially in the areas of decision making related to spending, changing pedagogy, and administrative/time management processes (World Bank, 2008). Other issues include implementation coordination, theft, and use of proprietary software (Doctorow, 2009). In light of the individual nature of these problems, barriers, and issues, deliberate attempts must be made to develop solutions within the context of the community where the technology potentially could be integrated, using local skills, resources, and local existing technologies (Jackelen & Zimmerman, 2011; Trucano, Hawkins, & Jimenez Iglesias, 2012). The best fit technology is not necessarily the most sophisticated, complex, or expensive. The best fit technology should be what is most appropriate for a specific situation and culture and should use local resources for a successful intervention (Fleer & Jane, 1999).

Against this backdrop, the funding and resources that administrators, agencies, and governments have provided to educational and corporate organizations have lead to increased access to technology. At the same time, these developments have placed mounting pressure on educators to transform schools (Brush et al., 2003; Brzycki & Dudt, 2005). It is unfortunate that there still seems to be a gap between technology’s presence and its effective integration in academic institutions, regardless of location (Eteokleous, 2008; Keengwe, Onchwari, & Wachira, 2008; Oncu, Delialioglu, & Brown, 2008). Many countries with well-developed and widely available technology systems still experience challenges related to teaching and learning technology integration.

Access is a fundamental and critical aspect to the future of technology integration. One indicator of such access is the computer–student ratio. The computer–student ratio varies greatly across the globe from far below international average ratios in countries such as Albania, Argentina, and Brazil to countries with ratios above average such as Austria and Norway (Pedrò, 2012). Although Dutta and Bilbao-Osorio (2012) reported a global average of 25 computers per student in 37 countries, they advised that the evaluation of how technology is used in education should be focused on “the core issue: the intensity and variety of uses of technology for enhancing the quality of learning” (p. 137).

There are multiple initiatives with the goal of providing computer and technology access to children and teachers. For example, the One Laptop Per Child initiative has provided more than 2 million laptops to students, teachers, and communities all over the world (One Laptop Per Child, n.d.). These laptops are designed to be low-cost and rugged as well as having low-power requirements. The mission of One Laptop Per Child is to “provide each child with a rugged, low-cost, low-power, connected laptop” (One Laptop Per Child, n.d.). In a 2012 One Laptop Per Child experiment in Ethiopia, Ackerman (2012) reported that 1,000 tablets (one for each child) with solar power were delivered to two villages with no instructions—and left in boxes with the message, “see what you can do with them.” The children began to explore and use the technology and within “5 days they were using 47 apps per child” (Ackerman, 2012, para. 6). Only in the future will the results of this experiment be realized. However, with access to technology, the promising future of teaching and learning with technology can be realized.

In this article, we focus on common forms of technology that are forecasted to be at the forefront of teaching and learning environments in the 21st century, computers with Internet access, and mobile devices. Despite the wide range of available hardware and software, the integration of the Internet with mobile devices across the global educational system is a growing trend (Trucano et al., 2012). Access to mobile devices is increasing. Mobile manufacturer Ericsson (2010) suggested that by 2015, 80% of people accessing the Internet will be performing that access through mobile devices. Perhaps more important for education, these Internet-capable mobile devices (e.g., tablets, phones) will outnumber computers by 2012 (Johnson, Smith, Willis, Levine, & Haywood, 2011): For example, Karrer (2011) reported that “in Japan, over 75% of Internet users already use a mobile as their first choice for access” (para 4). Changes in Internet connectivity options are enabled through the emergence of three trends focused on availability: Internet-capable mobile devices, flexible web content, and accessible networks (Johnson et al., 2011).

The 21st-Century Push

Educational systems have been inundated with a wide variety of technologies, from the classroom, to the school, to the district, and beyond, in hopes that those technologies would improve student performance—and, consequently, reduce student failure rates. The integration of the philosophy and theory related to educational or instructional technology includes the combination of process redesign, hardware, software applications, administration, and pedagogy into the education and training setting to influence learning and performance (Seels & Richey, 1994). In the 21st century, teachers and students have access to a constantly evolving series of technologies, which has facilitated a continued interest in how to use these types of technology in educational environments. Through the incorporation of educational technology models and theories, the practitioner’s focus is specifically on how technology can be used to improve student performance through processes, procedures, and tools. Processes and procedures may comprise any task or intervention involving anything from a simple instructional strategy to a complex instructional system.

Hardware such as computers, mobile devices, smart boards, and projection systems, response clickers, video conferencing, have, year-by-year, been introduced into the teaching and learning environment. The technology-rich 21st-century classroom includes technologies used for multimedia projects, as well as interactive whiteboards, online databases for research, and online tools that streamline communications between and among teachers, parents and students. Other technologies that help to build technology-rich environment include Web 2.0/3.0 tools such as blogs, wikis, and social networking sites that provide teachers and students a variety of ways of
communicating. In addition, the idea of software tools as technology solutions (e.g., productivity software, drill and practice, assessment, survey, multimedia, data mining and warehousing, and statistical analyses) have been touted as the answer to various problems—without a clear definition of exactly what are the problems. Performance is a key component of any definition of success in an era of accountability and reform; but other outcomes such as completion, efficiency, and access should be in the mix of any technology integration model. Technology in the classroom invariably mandates a culture transformation from traditional to innovative.

**Technology Integration: Is Transformation Possible?**

The explosion of ever-changing technology and the corresponding requirements of technology use have been a constant theme in education and a continuing issue affecting the integration of technology in classrooms. Multiple meta-analyses on how technology influences variables from motivation to performance have been conducted (Moran, Ferdig, Pearson, Wardrop, & Blomeyer, 2010; Tamin, Bernard, Borokhovski, Abrami, & Schmid, 2012; U.S. Department of Education, 2010). In the 1980s, Apple Classrooms of Tomorrow led the way in thinking about how technology could transform teaching and learning (Dwyer, 1994). Dwyer reported on the transformation of the learning environment in eight areas: classroom activity, teacher role, student role, instructional emphasis, concept of knowledge, demonstration of success, assessment, and technology use.

Dwyer (1994) outlined fundamental transformations leading to the notion that classrooms could be interactive and student centered; where the student was no longer the blank slate or the empty vessel, but rather, a collaborator in an environment in which the teacher was a partner in the learning process—and, at times, even the learner! No longer would teachers focus on direct instruction and expectations that students recite a high number of facts that had been memorized for traditional multiple-guess tests. Instead, students would be expected to explore relationships through problem solving, inquiry, and interpretation of facts and relationships to develop conceptual frameworks permitting them to showcase their knowledge through mastery, portfolio, and performance assessments, as found in authentic learning environments (Lombardi, 2008). Last, Dwyer showcased the transformation of technology use from simple drill and practice to a complex system consisting of “communication, collaboration, information access, and expression” (Dwyer, 1994, Figure 1), and the question became, “How does technology plus people transform education systems?” In response, the short answer is teachers, administrators, and policy makers must facilitate the transformation of their schools to take advantage of technology.

Technology integration is most effective when careful attention is paid to the purpose, role, and potential issues of process. On the basis of the needs of the stakeholders, the integration of technology should be considered within the cultural context and designed to meet the needs of those stakeholders. Appropriate technology can be hugely helpful in providing students with tools to become productive learners and assist in creating a learning environment that permits active engagement in content that would not otherwise be readily available. The interaction of technology and purposeful use create that transformational environment where change can occur; successful technology use in the classroom invariably mandates a cultural transformation from traditional teacher-directed to innovative student-centered learning where students are engaged in learning through teamwork, critical thinking, and problem solving. These experiences further provide students with the ability to communicate using multiple outlets (Bellanca & Brandt, 2010) that promote a variety of 21st-century skills.

**Technology and Transformation**

Using educational technology theories and models, an instructor or teacher can create a classroom environment that focuses on facilitating effective, efficient, and motivating teaching and learning processes. In this examination of technology and transformation, we focus on educational technologies and how those technologies can be a transformational force in education. With innovation, change occurs; change can be defined as meaning “to alter the course or to transform the direction of an activity, process, organization, or situation” (Van Tiem, Moseley, & Dessinger, 2012, p. 61). Change facilitates transformation and sweeping change can be caused by an infusion of technology into the environment. Christensen (2008, p. 44) talked about “disruptive” innovation as it relates to organizational success in intervention implementation. From Christensen’s perspective, an innovation can be first viewed as providing stakeholders with a reason to use the innovation. The disruptive element involves fundamental changes in the environment through different uses of the intervention.

The advent of the personal computer, the Internet, and the World Wide Web has led to a focus on delivery of traditional materials through these channels. This process is initiated with educators focusing on teaching students how to think rather than what to think (U.S. Department of Education, 2010). While there are countries in which teachers are seen as the purveyors of knowledge or the “sage on the stage,” in other countries a move has been underway to expand the role of the teacher to one of guide or facilitator, to help students pursue individualized paths for content acquisition and skill building. The use of technology can take many forms in both of these paradigms. In educational settings where the teacher is the dispenser of knowledge, computers and mobile devices can be used to facilitate learning by serving as resources for course content and materials, providing additional drill and practice opportunities to strengthen skills, and expanding teachers’ options when preparing and delivering course content.

In many settings, however, computers and mobile devices can lead to a paradigm shift where the focus of the learning environment is on the student rather than the teacher. A student-centered learning environment establishes the student as the focal point. When student needs are known, best practices and strategies can be identified and implemented that address and meet the student’s needs. The paradigm shift
that facilitates the transformational learning environment requires a different set of roles and responsibilities for teachers and students because the learning environment no longer resembles the rigid 20th-century traditional classroom. Rather, a flexible, collaborative environment with technology-rich curriculum and high expectations becomes a transformational force in education, in which students access information almost instantly from a variety of resources and individuals.

Current Technology Trends in Education

Many schools are providing classroom access to information, resources, tools, and people via the Internet and school networks across the globe (Johnson, Schwabb, & Foa, 1999). Computers and networks are common forms of technology resources in schools. Computer-based educational materials are accessible via the Internet on tablets, smartphones, netbooks, and other mobile devices (Friedman, 2012; Vosloo, 2012). In addition, as access improves, publishers are increasing their curriculum offerings in electronic formats. It is not surprising that increasing numbers of teachers are faced with the dilemma of how to learn to use and effectively incorporate all of the available tools into their teaching practice. Johnson and colleagues (2011) identified the top trends and expectations for the integration of technology into school districts and classrooms. These trends included (a) the expectation to learn, and study whenever and wherever they are; (b) technologies are increasingly cloud-based, and notions of information technology support are decentralized; (c) the world of work is increasingly collaborative, driving changes in the way student projects should be structured; and (d) the abundance of resources and relationships made easily accessible via the Internet is increasingly challenging the traditional notion of educator roles.

The trends identified by Johnson and colleagues (2011) further support the notion that digital tools will have the ability to help transform teaching and learning environments. These trends embody the tenets of a transformative philosophy of education through the use of collaboration, instructional delivery, and alignment of learning to student needs. Technology and the digital environment expand learner access beyond classroom walls; create access opportunities where none existed before; and provides support and collaboration experiences not previously possible. The ubiquitous computer and digital access enable the realization of the teaching and learning vision as identified by Johnson and colleagues (2011).

The Digital Native Student

Students of the 21st century, pre-Kindergarten through college, represent generations who grew up with technology. These students, frequently called digital natives, have spent their entire lives surrounded by computers, using them for videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age. Digital natives are used to receiving information quickly, parallel processing, and multitasking. They prefer random access and function best when networked. They thrive on instant gratification and frequent rewards. Digital natives make choices about how to generate, obtain, manipulate, and display information, actively think about information, make choices, and execute skills in real time to resolve real problems (Johnson et al., 2011; Prensky, 2001).

Digital natives use mobile technology as a tool or a support for communicating with others, simultaneously; they are actively engaged in learning when using these devices. This active environment process is quite different from being a traditional passive, recipient vessel that acquires information transmitted by a teacher, textbook, or broadcast (Arnone, Small, Chauncey, & McKenna, 2011; Michel, Cater, & Varela, 2009; Samson, 2010).

One of the strongest advantages of mobile technology and digital access is the opening of the world of information that contributes to the ability of students to develop 21st-century skills at the same time (Pacific Policy Research Center, 2010). A critical part of the skills needed by digital native students are those related to collecting, retrieving, organizing, managing, evaluating, and synthesizing information (Pacific Policy Research Center, 2010).

The ability to access information through mobile technology facilitates the ability of students to acquire and practice those 21st-century skills from anywhere they have Internet access. Global awareness is one of the themes in the 21st century learning skill set. The use of mobile technology and digital access permits students to communicate, collaborate and learn from individuals living in different countries, different cultures, and different religions. The ability to access information and communicate with others provides teachers and students the amazing opportunity to engage with individuals and ideas around the world, leading to an “environment of openness and mutual respect” and developing students who can “engage with global issues and diverse learning communities” (Pacific Policy Research Center, 2010, p. 2).

A common teacher-reported effect on students in environments where mobile technology has been used involves an increase in motivation (Green & Hannon, 2007). When students are using these devices as a tool or a support for communicating with others, they are in an active role rather than the passive role of recipient of information. Mobile technology use also allows students to be actively thinking about information, making choices, and executing skills that are missing in typical teacher-led lessons. Moreover, when technology is used as a tool to support students in performing authentic tasks, the students are in the position of defining their goals, making design decisions, and evaluating their progress. The digital native students, born into a technology-rich age with widespread mobile device access, are extremely capable in adapting skills and thinking processes to embrace a new world of teaching and learning—often more so than the teachers who are instructing them. As a result, students have a view of the world and access to information that differs significantly from that of students who attended school prior to the advent of the Internet. Teachers have to embrace this reality and use the technology tools available in a manner that will build on these new opportunities to explore and interact with the world.
with technology, in and out of classrooms, are anticipated by the learners of the 21st century. Teachers must provide these students with opportunities to explore and interact with the world in their own way.

**The Rise of the Digital Native Teacher**

Digital native adults are entering the teaching profession and will have their own perceptions of how technology is used in teaching and learning environments. Just as the digital native student has expectations about how and when technology should be used in class (Arnone et al., 2011), the digital native teacher will have expectations of how technology can be used. Traditional pedagogical approaches of direct instruction, drill and practice, and assessment can be easily facilitated through technology integration (Kukulska-Hulme & Traxler, 2005). For example, teachers can use the Internet to research content and find resources that can be then present through technologies such as smart boards, projectors, and computers, either in whole-class or centers. Textbooks and course materials can be supplemented with up-to-date information that serves as a resource to facilitate student research and discussion.

However, for the digital native student, the traditional pedagogies may no longer be sufficient to create a learning environment that is motivating and relevant. Accordingly, the digital native teacher will be obligated to embrace the technology options available for transforming the teaching and learning environment. The paradigm shift to student-centered learning environments requires teachers and students to engage in strategies that transform roles and responsibilities. For example, teachers may work with students to set goals, establish collaborative work groups, and provide guidelines about resources and projects (Arnone et al., 2011; Dwyer, 1994). In the model outlined by Dwyer, student's work on their own technology-supported products and projects, while the teacher rotates through the room, asking about the reasons for various design choices and suggesting useful resources. These activities and resulting learning outcomes are based in real situations and use project-, inquiry- or challenge-based frameworks.

**Bridging the Gap**

Regardless of how technology is used in teaching and learning, teachers face numerous challenges regarding classroom instruction. For example, an ever-changing subject matter requires teachers to update their content and knowledge base on a continuing basis. The types of resources available and the multiple forms of subject matter representations such as databases, narratives, video, and audio, complicate the job of the teacher as they gather resources to share with and teach students (Steele, 2012). Even more compelling, the relationships between teachers and students are influenced by the integration of mobile technology as evidenced by the types of instructional method (e.g., collaborative learning, project-based). In these models, teachers and students form learning communities in the pursuit of knowledge and skill acquisition.

There are several important issues that should be addressed before the implementation of mobile technology within a school. Be it laptops, mobile devices, or desktop computers for the classroom or school, the most important question to consider is “Do you have the infrastructure to support your mobile technology and Internet access?” For organizations working to integrate technology in under-developed countries, this issue includes ensuring that schools have the resources needed to sustain the technology purchased and ensure the maintenance, connectivity, and access points to the Internet and World Wide Web (Strudler & Hearrington, 2009). In addition, consideration should be given to such matters as identifying how, when, and where the mobile devices will be updated and stored. Last, careful consideration should be given to the current and future role of the mobile device in the classroom. The plan for technology integration and use will factor heavily into future success of the technology-rich environment.

**The Evolution to the Digital Mobile Classroom**

Even in locations with little access to electricity, mobile technologies can be easily found (Steele, 2012). Steele reported, “In developing nations, 79% of the population has a mobile phone” (para. 3). With these mobile technologies, students and teachers have unparalleled access to information at the tip of their fingertips.

The digital native students see mobile devices as a normal and typical tool that can be used in all facets of their lives, including education (Green & Hannon, 2007). Mobile devices permit students to use media and technologies to create, learn, and communicate in new ways. Access to these technologies opens new avenues of teaching and learning for students across the globe. Technology is so as ubiquitous that the use of technology has been hardwired into their ways of thinking and operating in the world (Klopfer, Osterweil, Groff, & Haas, 2009).

At the same time that students have increased access to personal technology, mobile devices have empowered and equipped educators to meet the needs of 21st-century skills required by global students. Mobile devices have the potential to reshape students’ learning experience, and can, in turn, re-shape classroom cultures. Educators who embrace the use of mobile devices in teaching and learning can leverage and take advantage of technology that is already in the hands of many students. At the same time, integrating already established student-owned mobile devices into the classroom allows students to learn without the need for the school to invest heavily in procuring these potential education tools—if they already exist in the environment (Warschauer & Matuchniak, 2010).

**Applications**

When properly configured, and appropriately used, mobile devices, such as the iPad or those running an Android operating system, serve as effective and efficient educational tools. There are all kinds of productivity and utility applications that can be used to streamline tasks and help students, teachers, and administrators make efficient use of their valuable time and resources (Strudler & Hearrington, 2009). When considering how technology can be used in the teaching and learning environment, all stakeholders must recognize that the technology...
itself, should not control curricular design or instructional strategies.

Mobile devices, combined with applications, permit the teacher to make good use of instructional tools (e.g., the technology) by aligning student characteristics with lesson content; lesson objectives; and instructional strategies. Regardless of the type of approach used to design technology-rich teaching and learning environments, a clear alignment of the purpose of the activity and the technology with the lesson will facilitate student engagement and, hopefully, improve performance. In Table 1, applications for different types of mobile devices in instructional settings are presented.

The Challenges of Integrating Technology Within the Classroom Culture

Groff and Mouza (2008) discussed six central factors, each with critical variables that interact with one another to produce barriers to implementing technological innovations in the classroom: (a) research and policy factors, (b) district/school factors, (c) teacher factors, (d) technology-enhanced project factors, (e) student factors, and (f) technology factors. Although all dimensions are important, not all of them can be manipulated or accounted for by individual teachers. The characteristics of various types of technologies can facilitate or hinder efforts to use technology; teachers cannot (in many cases) directly influence or alter those characteristics. Even schools that are eager to adopt new technologies may be critically constrained by the lack of necessary human resources and the financial wherewithal to realize their ideas (Hargreaves, Earl, Moore, & Manning, 2000). Still other teachers are located in buildings that simply were not designed to provide the radio frequency transparency that wireless technologies require and find themselves shut out of many potential technology options. Technology-rich instruction can enhance student performance and prepare students for work in the 21st century; schools should provide seamless access to technology resources to meet those goals (Fullan, 2007). Students do not just crave access, they expect an integrated learning experience:

They are used to the instantaneity of hypertext, downloaded music, phones in their pockets, a library on their laptops, beamed messages and instant messaging. Students have been networked most or all of their lives and have little patience for lectures, step-by-step logic, and “tell-test” instruction. (Prensky, 2001, p. 3)

And, teachers cannot perform their duties without needed technology.

Teachers may be reluctant to adopt student-centered approaches using technology and mobile device integration because they lack the knowledge needed to do so. Those teachers need to obtain basic technology skills before they can adopt student-centered practices with technology (Hew & Brush, 2007; Zhao, Pugh, Sheldon, & Byers, 2002). Teachers typically lack time to learn new technology and prepare instruction that integrates technology into the curriculum. Dedicated time and effort must be available to permit teachers and teacher collaborators to integrate technology into the entire school’s curriculum so that it becomes a fundamental part of the teaching and learning environment. Without this dedicated time, technology integration tasks can become barriers rather than opportunities.

Technology-integration planning should focus on ensuring that time, patience, and commitment are included in the processes that is encouraging and supporting for teachers as they learn to integrate technology into their daily routines and curriculums (Hew & Brush, 2007). To help better prepare teachers to integrate mobile technology in student-centered ways, a model of technology integration is needed, one that is sensitive to the barriers that teachers face as they learn to use technology with new instructional practices (Kopcha, 2010). Moving teachers toward using technology in student-centered ways is a multi-faceted effort that has a better chance of success when implemented over long periods of time and with appropriate support (Hew & Brush, 2007).

Infrastructure and Access

There is a great need for improved infrastructure and access across the globe. Underdeveloped countries are still considerably behind developed countries in many areas, including information technology infrastructure, but with the help from governments, foundations, and other countries, access to the Internet is fast becoming a reality throughout the world. Experts expect to see access increase drastically as technology makes it possible to use even the minimal infrastructure that exists in many areas to provide access to more people, even in remote locations (Strudler & Hearrington, 2009). Many developing countries are working hard to provide Internet access to their populations. The majority of these countries also receive support from the West, with, for example, Americans and Canadians helping to develop the technology required to access the Internet, even with limited and slow Internet access (Strudler & Hearrington, 2009).

Looking Forward: The Questions

Since the introduction of the blackboard, teachers have faced questions regarding why and how technology could and should be used in teaching and learning processes. At the same time, leaders of teacher education preparation programs, beginning teacher programs, and in service professional development programs have struggled with questions regarding identification, selection, or presentation of strategies and best practices to develop the knowledge, skills, and abilities that teachers need to meet the demands of a diverse and rapidly changing work environment. Questions related to technology use in education have not changed:

1. How does technology influence student performance?
2. What technology should be used in classrooms?
3. Does technology make a difference in teaching and learning?
Table 1. Applications and strategies for integrating mobile devices into the classroom

<table>
<thead>
<tr>
<th>Application</th>
<th>Integration strategies</th>
<th>Tips</th>
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<tbody>
<tr>
<td>Dropbox</td>
<td>Store files in the cloud to be accessed using any Internet-connected device with the Dropbox app installed. Students can access teacher-developed files for use at home, in the Library, or during field research activities.</td>
<td>For use on multiple devices (e.g., iPad, iPod, iTouch, Android). Application is free. Have students practice in class the process to make sure they all can access Dropbox files.</td>
</tr>
<tr>
<td>Evernote</td>
<td>Take notes, make to-do lists, and clip Web pages; save these items in the cloud to be accessed by any Internet-connected device with the Evernote app installed.</td>
<td>For use on multiple devices (e.g., iPad, iPod, iTouch, Android). Application is free. Model list building and prioritization for students to develop time management skills.</td>
</tr>
<tr>
<td>AudioNote Lite</td>
<td>Annotate audio recording with text or handwritten notes. Recordings limited to 10 min per note or 2 hr total. (Combines the functionality of a notepad and a voice recorder.)</td>
<td>For use on multiple devices (e.g., iPad, iPod, iTouch, Android). Application is free. Highlight important or complex information for further description for students to refer to during study and practice.</td>
</tr>
<tr>
<td>iBooks</td>
<td>Download and read books from Apple’s online book store.</td>
<td>For use on multiple devices (e.g., iPad, iPod, iTouch, Android). Application is free (resources will have associated fees). Use electronic resources to fill content and practice needs. Have students practice reading aloud to increase fluency.</td>
</tr>
<tr>
<td>Kindle</td>
<td>Download and read books from Amazon’s Kindle book store.</td>
<td>For use on multiple devices (e.g., iPad, iPod, iTouch, Android). Application is free (resources will have associated fees). Use electronic resources to fill content and practice needs. Use as part of a center activity to answer questions about and analyze problems.</td>
</tr>
<tr>
<td>Nook</td>
<td>Download and read books from Barnes and Noble’s online bookstore.</td>
<td>For use on multiple devices (e.g., iPad, iPod, iTouch, Android). Application is free (resources will have associated fees). Use electronic resources to fill content and practice needs. Form a book club to discuss common books and create author profiles. Contact author/publisher for interactive Internet-based experience of question/answer.</td>
</tr>
<tr>
<td>Absolute Board</td>
<td>Take handwritten notes, sketch ideas and then take a snapshot of your board to e-mail.</td>
<td>For use on multiple devices (e.g., iPad, iPod, iTouch, Android). Application is free. Have students “fill in the blanks” of lecture as review and practice.</td>
</tr>
<tr>
<td>SyncSpaceShared Whiteboard</td>
<td>Take handwritten notes, type or dictate text, sketch ideas, then e-mail your document. Can also use collaboratively.</td>
<td>For use on Android. Application is free. Have students share ideas about projects and reports to build class portfolios and projects.</td>
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4. How do teachers use technology in classrooms?
5. How does technology change the classroom and teaching and learning culture?

The word, technology, can be interpreted differently depending on the decade, while the types of technology could include the many technologies previously discussed, such as the film strip, overhead projector, laser disc, computer-based instruction, web-based instruction, etc. The fundamental question remains: How can technology be integrated into the teaching and learning environment in the most effective and transformational fashion? It is clear that the research related to technology use in classroom is mixed. There is a long historical record of researchers who have studied questions related to technology and there has been no definitive answer to the question, “Does technology improve student performance?” Perhaps this question is one that cannot be answered. Perhaps the question is not the right one. A better question to ask might be, “How can technology be used to transform education, the classroom, the school, the district and the educational system to meet the needs of the 21st-century student?”

Conclusion

Technology by itself can do nothing. Technology in conjunction with engaged, excited, and motivated students, and innovative teachers and administrators can change the world.
Using best practices in the classroom, school, and district, a culture shift in which teachers and students are engaged in rich and exciting teaching and learning environments can be facilitated. Transformational learning can lead to, not only technology infusion in individual classrooms (Kelly, McCain, & Jukes, 2009), but also a sustained change in the school culture. School culture and environment can be transformed by technology. It also is critical to understand the global factors that contribute to the process of transformations as related to technology use, innovation, and transformation (Kitchenham, 2009). A philosophy that promotes educational technology and innovation, consultation with teachers regarding educational technology decisions, encouragement of collaboration as a habit of mind, and the creation of professional learning communities, all affect transformative learning and are vital for those processes to occur (Kitchenham, 2009).

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