21st century classroom resources

Chapter · January 2015

CITATION
1

READS
9,151

2 authors:

Mary Mcdonald
Hofstra University
24 PUBLICATIONS **163** CITATIONS
SEE PROFILE

Dana Battaglia
Adelphi University
11 PUBLICATIONS **49** CITATIONS
SEE PROFILE

Chapter 11

21ST CENTURY CLASSROOM RESOURCES

Mary E. McDonald[1,·] and Dana Battaglia[2]
[1]Hofstra University, New York, US
[2]Adelphi University, Garden City, NY, US

ABSTRACT

There is a growing need for educators to adapt to 21st century learners. Educators are not only charged with maintaining a current knowledge base in terms of teaching techniques, but also with creating interesting curriculum-driven lessons which both motivate and engage students. The way in which students learn differs due to having grown up with access to that technology. This chapter will focus on the use of 21st century classroom resources to create a classroom environment using Universal Design for Learning (UDL), as well as technological pedagogical content knowledge (TPACK), so that all learners can access the curriculum. The first part of the chapter focuses on classroom and mobile computing and the second part on cloud computing. There will be a discussion of technologies and their applications in the classroom. In addition, for each technology discussed, there will be a chart outlining the application of TPACK, as well as a vignette showing the use of technology in providing a more UDL environment for a learner. The importance of not only using technology but also using it in an effective manner with thoughtful planning and delivery is crucial for the future of our learners.

INTRODUCTION

21st Century Classroom Resources

In the 21st century, technology has become a large part of society (Bechina, and Kramer, 2013). While innovative, exciting, and a dynamic teaching tool, use of technology still requires an investment of time, and subsequently, professional development. Further

· Corresponding author: Mary McDonald, Hofstra University, School of Education, Hagedorn Hall Room 160, Hempstead, NY. E-mail: Mary.E.McDonald@hofstra.edu.

requirements include time to experiment with a technological endeavor, and follow up support. Groff and Mouza (2008) specifically identify six factors influencing technology use for teachers as follows: 1) legislative (e.g., policy and research), 2) district/school based (e.g., administration and school/community environment), 3) teacher (e.g., technology skills and proficiency, perspective), 4) technology-enhanced projects, (e.g., school culture and distance from the "norm," dependence on others external to classroom), 5) students (e.g., experience and background, technology proficiency, attitudes/beliefs), and 6) technology (e.g., hard drive, memory, computer system) itself. These six factors are important considerations when using technology in the classroom. In particular, attention to curriculum content, pedagogical style, and technology are thought to be the foundation for effective teaching and learning (Mishra and Koehler, 2006).

In recent research, a framework to account for the interrelatedness of teacher knowledge and use of technology was introduced (Vanderlinde and Van Braak, 2013; Mishra and Koehler, 2006). Of interest to the authors is a technological pedagogical content knowledge (TPACK) framework. The relationships between content, (e.g., knowledge about actual subject matter that is to be learned and taught), pedagogy (e.g., the robust knowledge regarding the process and practice or methods of teaching and learning), and technology (e.g., knowledge about computers/tablets, operating systems, digital media, video, and use of the internet) are complex, with several levels of mastery and usage (Mishra and Koehler, 2006). Therefore, TPACK is an interdisciplinary compilation of all three aforementioned forms of knowledge, emphasizing the complexity and interrelatedness of these three (Mishra and Koehler, 2006). Synergistic application of TPACK is instrumental in successful learning in the 21st century classroom.

Having thorough knowledge about content alone (in the absence of pedagogy and technology) will not suffice for student success. The same is true for thorough knowledge about pedagogy (alone), and/or technology (alone). Collectively, an understanding of content, pedagogy, and technology is critical to have a positive impact on the classroom learning environment. See TPACK framework diagram in Figure 1.

How students learn has fundamentally changed in the 21st century. Today's students are the first generation to be fully immersed in technology. Having been born in the digital era, these children have been exposed at an early age to technology above and beyond laptops (e.g., gaming, tablets, digital music players, webcams, and smart phones) (Prensky, 2011).

As a result, how students engage in the learning process, while interactive, is different from that of students from previous generations. Prensky (2011) refers to students in the 21st century as "digital natives." That stated, there still remains a need for so-called "soft skills" such as thoughtful planning of activities and creativity (Walser, 2008), for technology. One example of a combination of soft skills and use of technology is kindergarten students creating I-Movies featuring solid shapes while studying math.

Students not only have to integrate facts about geometry, but also work in groups during the video production phase. According to Walser (2008), the ability for kindergarten students to identify 3-D objects in the environment, take pictures of them, and narrate videos describing them is evidence of clinical integration.

There are several general uses of technology in the classroom. How teachers apply the use of these general forms of technology in content areas (i.e., mathematics, writing, social studies, and science) is diverse.

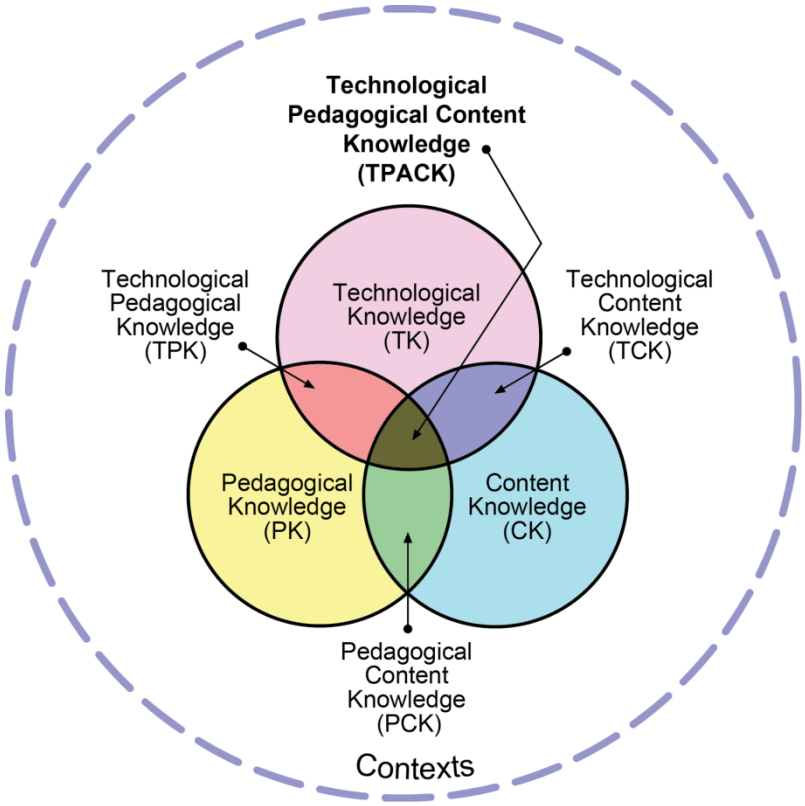

Figure 1. Reproduced by permission of the publisher, ©2012 by tpack.org (http://tpack.org).

As per TPACK (2012), it is not sufficient to simply have access to technology. Rather, engaging in the process of teaching *using* technology as a teaching tool is the focus of this chapter (Carr, Jonassen, Litzinger, and Marra, 1998; Mishra and Koehler, 2003).

As we look to create classrooms that are conducive to "all learners", we see that technology can often be the tool used to ensure an appropriate educational environment for the diverse learners who make up our classrooms today. The Universal Design for Learning (UDL) approach allows for us to provide access to all students to the curriculum at the forefront rather than as an afterthought or retrofitting (Edyburn, 2013; McGuire, Scott, and Shaw, 2006; Spencer, 2011). UDL also allows for learners to have multiple means of expression. Diverse learners can express their knowledge in a variety of ways; the technology available makes it easier for teachers to support the students in expressing this knowledge. One student may express his knowledge by typing a paper while another may create a slideshow or video to share his understanding of the curriculum. Lastly, the UDL approach allows for students to be engaged and motivated when learning within a context. It is the UDL approach, utilizing technology for all learners that will provide all students with access to the curriculum in an engaging and productive way.

Subsequent sections of this chapter will introduce uses of technology as an instructional tool in a myriad of content areas in the 21st century classroom (e.g., classroom and mobile computing, cloud computing, Web 2.0, and hybrid learning), with specific examples to highlight and expand upon each. Part I of the chapter and the first area to be addressed is classroom and mobile computing.

The topics included are whiteboards, laptops and tablets.

Part II of this chapter will address cloud computing. Topics included in this section are *Google Drive*, web 2.0 applications, wikis, blogs, and *VoiceThread*. Both sections will include an overview of each of the various types of technology, followed by an application in the classroom, and a vignette highlighting the use of UDL and technology.

PART I: CLASSROOM AND MOBILE COMPUTING

Classroom and mobile computing is becoming more and more prevalent as technology advances and becomes more accessible. The 21st century classroom is now becoming a technology rich environment and our learners are used to having this technology available to them at all times both inside and outside of the classroom. This section will focus on the use of interactive whiteboards, laptops and tablets.

Interactive Whiteboards

Understanding interactive whiteboards. An Interactive Whiteboard (IWB), is a touch-based interactive device connected to a computer, displaying information by way of overhead projector (Manny-Kan, Dagan, Tikochinski, and Zorman, 2011). Additional (optional) components may include, but are not limited to the use of a color-changing electromagnetic pen and a remote control. Whiteboard lessons typically include visual presentation with auditory feedback and often video demonstration as well. Lastly, the students often interact with the whiteboard, manipulating objects and images directly on the board itself.

This multi-modal approach to learning allows for the diverse learners to be more engaged and gain access to the curriculum in a way that meets their needs. Therefore, use of IWBs speaks directly to UDL in that they allow for multiple means of expression, engagement, and representation.

IWBs were originally developed for the business world, and subsequently applied to the field of education (Moseley, Higgins, and Bramald, 1999). Descriptive studies claim increased student engagement and elevated interest in curricular content (Cogill, 2003; Glover and Miller, 2001; Lantham, 2002; Levy, 2002; Smith, Higgins, Wall, and Miller, 2005; Turel, 2010). Benefits of IWBs in the 21st century classroom include integration of multiple modalities (i.e., visual, auditory), as well as integration of multimedia (i.e., videos, websites, pictures, charts, graphics) (Ekhami, 2002; Higgins, Beauchamp, and Miller, 2007; Johnson, 2002; Levy, 2002), thereby increasing student motivation to participate in classroom activities (Lacina, 2009). Lessons conducted on interactive whiteboards allow for diverse learners to be engaged through multi-media presentations.

Applications of interactive whiteboards in the classroom. There are multiple uses for IWBs in the 21st century classroom. Some examples include, but are not limited to emphasizing or highlighting critical text (Turel and Demirli, 2010), using pictures and videos to lay the groundwork for a lesson, brainstorming, collaborative writing and problem-solving (BECTA, 2006), differentiating instruction, and game playing (Smith, Higgins, Wall, and Miller, 2005).

Specific examples of how to use IWBs in the 21st century classroom are provided in the areas of language arts, science, and social studies. In language arts, IWBs may be used for purposes of dictation, demonstrations for cursive writing, vocabulary bingo, word completion for phonics activities, and semantic webbing (e.g., word spiders). In science, students can label parts of the human skeleton, view stop motion videos of photosynthesis, and see animations of the motion of the Moon around the Earth. In social studies, students can rotate a compass to depict points on a map, identify countries with their corresponding cities and agriculture, and match the names of a landscape with corresponding pictures and animations. Teacher-guided structured learning activities at the kindergarten level have also supported the efficacy of use of IWBs in the classroom (Fessakis, Gouli, and Mavroudi, 2013). See Table 1 for a demonstration of the interrelationship between the use of IWBs and the TPACK framework.

UDL vignette. Anthony is in the fifth grade. He is an endearing student who works hard in class. He is unable to sit for long periods of time and has difficulty paying attention to a teacher when she is speaking to the entire group.

Table 1. Sample of the interrelation between Interactive White Boards (IWBs) and TPACK framework. Technology should be considered as IWBs throughout

Major Subject	Content	Pedagogy
Language Arts	Dictation	Pre-recording words and presenting them using IWBs. Inviting a student to come to the board and spell out by writing on board) the word in front of class.
	Written Composition	Using graphic organizers as a writing template for students. Using *Popplet* (Popplet.com) to develop thoughts and create sentences to then create a written product.
Science	Human Skeleton	Have students build a human skeleton by arranging target bones in a pile on the lower portion of the screen. Name a bone and have student come up and assemble skeleton.
	Photosynthesis	Link to student interactive textbook and watch stop motion video of photosynthesis. Take screenshots and ask students questions. Write on screenshots and send home to students via email or post to class website.
Social Studies	Using a compass	Provide a map of the local neighborhood. Overlay a compass on it with an avatar. When pointing "north" the avatar moves northward.
	Identifying countries and major cities	Provide students with a flag representing a particular country. On the back of the flag, provide students with clues regarding landscape, agriculture, and related vocabulary. Break students into groups of two. Using an IWB, have the first student locate the country on a world map. Have the second student locate the major city within that country.

He does, however, benefit from interactive experiences, and is great with his hands. He does not like social studies because he has difficulty reading the textbook independently (i.e., silent reading), and retaining information from his teacher's lessons presented orally. Anthony is sitting in class, and his teacher announces that it is time for social studies. Anthony begins to get fidgety. Anthony's teacher is very perceptive, and has noticed Anthony's physical movement. Luckily, she is a self-evaluator, and realizes that previous strategies (i.e., assigning him to a peer for help, telling him he does not have to do the work) have not helped. Anthony is a 'pleaser', and wants to achieve success similar to his peers.

Today, Anthony's teacher announces that she will be delivering the social studies lesson using the interactive whiteboard. The goal of her lesson is for students to identify major cities in countries. She begins her lesson by playing the national anthem for a country then calling students up to the whiteboard to drag a flag onto the particular country. Once this is done, she breaks the class into small groups. Each student is assigned one country. Each group takes turns on the whiteboard, scanning over its assigned country. As they scan their county, information appears by way of picture, text, and video. The students take turns taking notes in their workbooks. When not at the whiteboard, they sit in various locations in the room, discussing their findings, based on their interactions with the whiteboard.

In the past, the options offered to Anthony during his social studies lessons have made him feel different from the other students. Because this lesson truly used multiple means of representation, this dynamic lesson paired with the technology available has Anthony feeling like he is a member of the class (as he should!). The use of UDL has afforded Anthony (specifically) access to the curriculum by way of multiple means of representation and engagement.

Mobile Computing: Laptops

Understanding laptops. As technological enhancements allow engineers to develop computing devices that are smaller than ever, Norris and Soloway (2011) state that learners are now in the "age of *mobilism*". They qualified this term by identifying three key characteristics: 1) connectedness (i.e., to people, at any time, regardless of physical location); 2) affordability (i.e., cost is rarely a barrier to access of a laptop computer and/or mobile device); and 3) *globalness* (i.e., mobile technology is a global phenomenon).

With the dawn of the age of *mobilism* (Norris and Soloway, 2011), several practical factors may influence the use of laptops in the classroom. Inan and Lowther (2010) found that teacher readiness and beliefs about implementation of laptop use in the classroom were predictors of the integration of this technology in classroom instruction. An overarching factor is technology support for educational initiatives, as well as professional development. The aforementioned factors are important considerations in predicting whether teachers will plan lessons for the 21st century classroom. Inasmuch, laptops can be a powerful tool in the 21st century classroom and a further demonstration of UDL.

By way of sharing of information, mobility, and the myriad of options in terms of expressing information, laptops meet the needs of diverse learners in today's classroom.

Applications of laptops in the classroom. As laptops replace the paper and pen of yesterday in some classrooms, there are a multitude of applications for their use in the 21st century classroom.

Lessons for collaborative projects in the areas of math and science have been made available to the public on the web. For example, teachers can design a "Math Hunt," whereby groups of students work together in different locations within the school setting (e.g., gym, lunchroom) to obtain evidence of geographic figures, fractions, etc., in these specific locations.

Each student group works with its laptop to graph its results, and then shares its findings with the entire class (National Science Teachers Association [NSTA], 1999). More current research on best practices for use of laptops in the classroom has supported similar activities (Zhu, Kaplan, Dershimer, and Begom, 2011).

A second example of the use of laptops to engage students in learning is in the area of science. Lesson plans for a "Seaside Science" project are available online (NSTA, 1999), emphasizing use of laptops during a field trip. Students are directed to experiential activities to classify sea life. Subsequently, students are broken into groups in order to create tables and graphs documenting details of this excursion. Their laptops are essentially tools embedded within the scientific method. See Table 2.

UDL vignette. Christopher is a third grade student who has difficulty reading text. He loves multimedia and says that he wants to be a video game designer one day. He likes science because he loves doing projects. He has actually told his mother that he can't learn when the teacher talks because it sounds like, "blah, blah, blah".

Christopher is excited to participate in the science fair, but like all students, needs to learn about the basic elements of scientific method. Today's science lesson is focused on just that. His teacher's plan for the class is to create a flow chart identifying and describing the six elements in the scientific method (i.e., ask a question, make a prediction, conduct an experiment, make observations, analyze results, draw a conclusion).

Rather than drawing arrows and writing these elements out on poster board (i.e., strictly visual domain), Christopher's teacher has provided a multimedia opportunity for all students. Through a private grant, she has secured laptops for group work. The students are broken up into groups of three and told to create a flowchart explaining the scientific method.

Using Microsoft *PowerPoint*, Christopher and his two buddies create a slideshow with animations for emphasis, audio recordings, and hyperlinks from *YouTube* for demonstrations along the way.

Table 2. Sample of the interrelation between Laptop computers and TPACK (2012) framework. Technology should be considered as laptops throughout

Major Subject	Content	Pedagogy
Math	Geometry	Searching for geometric shapes in the environment, taking pictures of these findings using the webcam, and graphing the number of shapes across different environments (e.g., home, school, outdoors).
Science	Scientific method	Create a flowchart using animations to define and describe formulation of a research question, conducting an experiment, and sharing results.
Social Studies	Early Presidents	Collect pictures of American presidents, and narrate *PowerPoint* presentation to describe their contributions to the establishment of the United States.

Using laptops and multimedia, Christopher not only learns about the elements of the scientific method, but his science project (i.e., which brand of diaper can hold the most water?) eventually wins first place in the fair! Rather than approaching teaching the scientific method using a single modality (i.e. strictly visual or strictly auditory), Christopher's teacher built in a multimedia option. By affording all students the opportunity to learn using multimedia from the start of this unit, Christopher did not require differentiation of the curriculum because it was designed for all learners from the start following the principles of UDL. He and all students in his class were provided with multiple means of engagement, representation, and expression.

Mobile Computing: Tablets

Understanding tablets. A tablet computer (henceforth termed "tablet") is a mobile computer with all components (i.e., touchscreen, circuitry, camera, and volume control) embedded as a singular unit (http://en.wikipedia.org/wiki/Tablet_computer). Many functions are accomplished by software applications (apps), which are easily downloaded from the web. Tablets may be used for multiple purposes: research, communication, collaboration and productivity.

Couse and Chen (2010) ask the critical question: "What is the viability for use of tablets with young children?" Using stylus-interfaced technology, they particularly examined progress in drawings of children in early childhood education. Outcomes revealed that engagement increased with the age of the students (up through the age eight). Preschool children acclimated well to use of tablet technology as a tool for instruction. Tablets were, indeed, found to be a motivating tool for maintaining student engagement. As such, it is evident that the use of tablet instruction in early childhood education may certainly support both the TPACK and UDL frameworks.

Applications of tablets in the classroom. Given the myriad of apps available for tablet computing, the possibilities for using tablets in the 21st century classroom are endless. Tablets are considered one of the newest trends of emerging technology in education (Quillan, 2011; Henderson and Yeow 2012). However as the landscape changes and more students exchange their paper and pencil for tablets, we must continue to be diligent to ensure that the teaching behind the technology is effective. For example, if teachers are using a particular application to teach a new area within the curriculum, the constraints of the app may limit the amount of information available, how the information is provided, and the responses required. Tablets are often an excellent way to engage students within a topic area.

For example, if a student was learning about geometry through *Geoboard* he might be more likely to be engaged. This could be a great way for visual learners to access the curriculum. However the novelty of the app may wear off over time and what's left is geometry, plain and simple. We cannot assume that all children will learn more or faster or better simply because the material is being presented on a tablet. Therefore our lessons need to be content rich, dynamic and engaging.

That stated, the use of tablets for interactive learning is recommended as a supplement to more traditional methods of classroom instruction. Students and teachers are reported to be positive about the use of tablets and even refer to them as an essential part of the "toolbox" for a 21st century classroom (Clarke and Svanaes, 2012).

Classrooms are said to be moving from the more traditional teacher-centric model of "I teach" to a student initiated "we learn" model with the push toward the use of mobile technology (Norris and Soloway, 2011). See Table 3.

UDL vignette. Joseph is in tenth grade. His fourth period class is illustration. He dreads going to this class because he is not a visual learner and completing his art assignments is always such a challenge for him. Today his assignment is to draw a self-portrait. He cringes. In the past, his teachers have either had him draw with the charcoal pencil and do the best he could (which was minimal work), or offered him another solution on the spot after observing him struggling and becoming frustrated (which was better but embarrassing). But today, Joseph's teacher had a plan…

Through generous grant funding and serendipity, Joseph's teacher was able to obtain tablets for all students in the class. The teacher, adhering to principles of multiple means of expression, provided all students with multiple options to express their self-portrait, including but not limited to charcoal, oil, photography, clay and tablets. Joseph chose to use the app *Morpholio Trace* on his tablet to complete this task. He was able to take a picture of himself using the tablet, then using a stylus and the aforementioned app, Joseph was able to trace his picture. Once complete, he could remove the picture he took, and submit his traced artwork as his self-portrait. Another option could have been to utilize a different app, (i.e. *Photo Booth*). He would take his photo and then enhance it using a variety of designs available. Not only did Joseph enjoy (and complete) this assignment, but he actually obtained the highest grade in the class. This was a first for him!

This technology based art lesson is a perfect example of providing students with multiple means of engagement (i.e., being motivated to actively participate in art class), as well as multiple means of expression (i.e., allowing students to choose from a variety of ways to express their abilities-such as oil, photography, charcoal and paper, clay and tablets). This application of UDL was successful in that it provided options for all of the students in the class.

PART II: CLOUD COMPUTING

Part II of this chapter will introduce the use of cloud computing as an instructional tool in a variety of content areas in the 21st century classroom (e.g., *Google Drive*, web 2.0, wikis, blogs and *Voicethread*), with specific examples to highlight and expand upon each. Of note, these forms of cloud computing may not be mutually exclusive. For example, Google Drive is a web 2.0 application and may be used as a wiki.

Table 3. Sample of the interrelation between tablet computers and TPACK (2012) framework. Technology should be considered as tablets throughout

Major Subject	Content	Pedagogy
Art	Illustration	Using a stylus and tablet, students can practice creating straight and curved lines, as well as creating drawings.
	Photography	Using different apps to create visual effects using sepia tones or creating collages (e.g., *Pic Stitch*)

Each section will include an overview of each of the various types of technology, followed by an application in the classroom and a vignette highlighting the use of UDL and technology. The term, "cloud computing," refers to use of both the internet and remote servers to maintain communication for purposes of maintaining data (Siegle, 2010). Through the use of cloud computing, students and teachers can use applications and save files without ever installing a software program onto their own personalized computers. Use of cloud computing essentially allows access to files from any location, rather than one specific hard drive. Cloud computing allows people to easily share files and collaborate with others. Examples of cloud computing include *Dropbox* and *Google Drive*. We will explicitly review the collaborative nature of *Google Drive*.

Understanding Google Drive. Google Drive is a free, cloud based storage service where one can upload and store files (http://www.google.com/drive/). In addition, users of *Google Drive* can both share and edit files simultaneously (i.e., files are continually synchronized). When working collaboratively, users can "chat" within an actual document, making the collaborative process both more creative and more personal. Of note, the *Drive* automatically saves and tracks changes in a history. Therefore, users can restore previous versions of the same working document. *Google Drive* accepts uploads of multiple file types (e.g., image files, video files, Microsoft Word and Excel, zip files). More recently, users can now use *Google Drive* offline (i.e., without internet connection) if using *Google Chrome* as a search engine.

Rowe, Bozalek, and Frantz (2013) reported on case-based blended learning using *Google Drive*. Outcomes of their work supported the notion that use of technology in the classroom facilitated deeper understanding and retention of material. Furthermore, students were able to work collaboratively creating working notes, identify their own knowledge gaps, independently research these gaps, and upload their findings to *Google Drive*. Being afforded the opportunity to work collaboratively in a synchronized manner (meaning at the same time) in one document, not only increases social presence but also speaks to the principles of UDL.

Applications of Google Drive in the classroom. Google Drive may be utilized to synchronously collaborate on lesson plans. In other words, two educators (colleagues) can work on the same lesson plan at the same time (https://docs.google.com/). In addition, student work can be published to share with the entire class. More interestingly, publishing documents can occur at various settings (i.e., within class, within school, on the web).

On the student end, students can submit work online. Finally, with respect to parents, they can both receive and submit supporting documents (i.e., permission slips) through *Google Drive*. Ultimately, *Google Drive* as it pertains to the 21st century classroom, can not only streamline collaboration and submission of work, but communication between the triad of individuals involved in the educational process (i.e., teachers, students, and parents), making it a highly efficient online tool for learning. See Table 4.

UDL vignette. Paul is an endearing kindergarten student. He loves to play and learns best through manipulative exercises. He has difficulty sitting still during circle time and listening to a story can be a challenge for him. He loves being with children his own age, building with blocks, and playing video games.

Paul's teacher understands that all of her students learn differently, so she tries to provide them with multiple means of representation to ensure their access to the curriculum. She has been able to obtain tablets on loan from the computer teacher for the week. She is introducing the concept of measurement (math).

Table 4. Sample of the interrelation between tablet and TPACK (2012) framework. Technology should be considered as *Google Drive* throughout

Major Subject	Content	Pedagogy
Math	Measurement	At the kindergarten level, students can describe attributes of the notion of "length" and "weight," as per the New York State Common Core State Standards. Students can directly compare an attribute two different objects have in common (i.e., the weights of two different rocks), and describe the quantity terms "more" and "less." Each student may be provided with a tablet, take pictures of their explorations, insert them in a word document and share their work with others in collaborative space of *Google Drive*.

She has gathered different materials and placed them in brown paper bags. Each group is provided with one paper bag, four tablets (one per group member), and one older child (fifth grade volunteer) to facilitate use of *Google Drive,* as well as appropriate use of technology.

The students are shown how to open a *MS Word* document, upload it to *Google Drive*, take pictures with the tablet, insert them side by side, and make comparisons amongst each other (which members of the group have "more" versus "less"). Paul went home from school, borrowed his mother's iPhone, spontaneously took pictures of rocks and flowers, and told her during dinner which had "more" versus "less." By using different means of representation, Paul, along with the entire class, had increased access to the curriculum.

Furthermore, Paul demonstrated increased motivation, through multiple means of engagement, as demonstrated by his independent exploration of "more" versus "less," outside of the school day, with his mother.

Other Web 2.0 Applications

Historically, web 1.0 was a source of information via the internet (i.e., websites). Subsequently, web 2.0 evolved, providing the user with increased user interface, applications, and storage facilities through the browser (O'Reilly, 2005). Examples of web 2.0 include social networking sites, blogs, wikis, video sharing, and web applications. Throughout this chapter, we will make multiple references to online resources, which may be considered to be web 2.0 applications. Note that many web 2.0 applications increase social presence and facilitate learning using multiple methods. Web 2.0 applications (e.g., *VoiceThread*) can be used in a variety of ways to either *augment* (i.e., classroom interactive activity) traditional classroom activities, or *supplement* (i.e., homework assignment) traditional classroom activities. Inasmuch, web 2.0 applications are frequently used in distance/online/blended learning for a variety of objectives in the 21st century classroom, thereby implementing principles of UDL, and highlighting the TPACK framework. In the context of web 2.0 applications, we will now turn our discussion specifically to the following educational tools in the 21st century classroom: wikis, blogs, and *VoiceThread*.

Wikis

Understanding wikis. A wiki is a web application that allows people to add, modify, or delete content in collaboration with others. Text is typically written using a simplified markup language or a rich-text editor. Wikis allow content management but differ from blogs in that there is no “owner” per se, but rather the wiki encourages the structure to emerge and evolve based on the need of the users (Mitchell, 2008).

A single page in a wiki website is referred to as a "wiki page" and the collection of pages is referred to as “the wiki”. The individual pages are hyperlinked together to form the actual wiki. The way in which the wiki is set up allows for dynamic and complex interaction using technology as the medium. One of the benefits of wiki technology is that pages can be created and updated very easily. Many wikis are open to the general public and do not require user accounts to access them (i.e., *Wikipedia* pages). Editing can be done by any of the users and the changes typically occur in real time. As the users continue to contribute to the page, it evolves and ultimately becomes a representation of the collaboration between the users (Leuf and Cunningham, 2001).

Applications of wikis in the classroom. Richardson (2006) stated that, when students are encouraged to write using wikis, they are further engaging in the social process involved. Writing entries in a wiki requires that a student have specific skills such as negotiation, cooperation, collaboration, and respect for one another's work and thoughts. Development of these interpersonal skills adds an additional layer to the process of writing that may have previously been seen as mechanistic and potentially creative but not necessarily social. Allison (2005) found that secondary students demonstrated advanced collaborative social skills when using a wiki. A further benefit was that students also learned effective writing strategies from their peers, rather than from a traditional, teacher-driven lecture and students also enjoy having their work published online and available for others to see, hear, and use.

Wikis can be used for several purposes in the 21st century classroom. Given the inherent collaborative design of wikis, activities such as web-writing or problem-solving, case review in small groups, and individual or group projects may be designed. These various uses of wikis draw on the traditional print paradigm with variations provided by a technology that remains "on the leading edge of the technology wave" (Culligan, 2003). Two (more specific) applications of Wikis in the classroom include: 1) wikis in writing and 2) wikis providing an international perspective on collaboration.

Some free wiki sites that may helpful for teachers who are getting started with wikis include: *PBwiki* (http://pbwiki.com), *Wikispaces* (www.wikispaces.com), and *Google Drive* (https://drive.google.com/).

Aligned with the notion of collaboration, wikis may further provide users with international perspectives on any given topic. Creating and sharing information in a collaborative fashion lends itself to being used with collaborators who are accessible through the internet. Use of the internet wikis also allows for students to write in a nonlinear fashion with links and layered pages. This type of writing allows students to bring the work of others into their writing in a way we have not seen before (Ferris and Wilder, 2006). These opportunities allow the nonlinear thinkers to express themselves in a way that is more in line with their thought processes. Wikis also allow the “writer” to use multiple modalities of expression (Jewitt, 2005; Kress, 2003). Students can use wikis to insert photos, graphics, music, and videos into their written projects.

By encouraging such multimodal compositions, greater opportunities for expression are provided to all learners, thereby allowing for genuine collaborative efforts.

Wikis are not confined to the physical walls of the K-12 classroom. As a result, collaboration by way of wikis may allow for opportunities to share information across time zones and cultures. Community building activities, in which educators develop collaborative projects with students from other countries, are now possible and transcend beyond the "pen pals" of yesterday. One example of this is the *ePALS Classroom Exchange* (www.epals.com) in which students collaborate in a global "day in the life" project. Students collaborate on a wiki for a single day sharing their contributions throughout the day (Ferris and Wilder, 2002). Students are practicing their own writing skills and also have an opportunity to be exposed to different cultures and experiences. Wikis allow for equal access to content for everyone. The contribution of the many writers may often be more valuable than the writing of one (Hendron, 2008). See Table 5 for a description of how the TPACK framework aligns with Wikis in the 21st classroom.

UDL vignette. Mia is in the 11th grade. She has a history of poor writing and academic underachievement. She has never liked school, and particularly dislikes English. She wants to go to college and study multimedia. A critical step in preparing for college success is to improve her writing. Mia's teacher knows that the traditional methods of vocabulary review (i.e., using flashcards) do not work for Mia's retention. In addition, she requires clear expectations. She is never quite clear as to what specifically her teachers want her to do.

When Mia arrives to English, she is elated to learn that she will be writing an expository essay, using assigned SAT words, by way of a *wiki* in a group with two peers. She immediately initiates the conversation, asking if she can be in charge of creating the background and linking *YouTube* videos as supporting evidence to their work. The videos have at least five of the ten assigned vocabulary words in them.

As an aside, in order to clarify expectations for all students, Mia's teacher provided the class a rubric, posted on the class website. By the end of the assignment, Mia earned full credit for her work on the wiki, and actually enjoyed, quite possibly for the first time, her assignment.

This multiple means of expression (i.e., incorporating multimedia in the expository essay, as well as offering a traditional paper and pencil task), afforded all students with access to the curriculum, thereby facilitating acquisition of vocabulary and experience with expository writing. Mia admitted that, when initially assigned this task, it felt daunting.

Table 5. Sample of the interrelation between tablet computers and TPACK (2012) framework. Technology should be considered as *Wikis* throughout

Major Subject	Content	Pedagogy
English Language Arts	Expository Essay	Students are charged with writing an expository essay in preparation for the Scholastic Aptitude Test (SAT). They are provided with a set of SAT vocabulary words, as well as a topic. The topic is the current state of health care policy in the United States. Students can create a *Wiki*, insert speeches from prominent public figures, photos, flowcharts, and a self-made YouTube video, and share this information on the web. They may post supporting evidence, and argue for or against present day health care policy.

In actuality, through multiple means of engagement, Mia made some social connections by sharing common ideas and working collaboratively on this wiki.

Blogs

Understanding Blogs. A blog is defined as a website (or section of a website) used for multimedia expression of thoughts or ideas (International Association for K-12 Online Learning [iNacol], 2011). Blogs are often maintained by one person, considered to be the "leader." Blogs have served as a source of journaling over the years and have piqued interest in a wide number of topics of discussion (Wang and Hsu, 2008). More recently, the idea of using blogging as a source of discussion and increased participation has been carried over into the educational realm.

Blogs allow for the creator to begin a discussion about a topic and then for the users to respond to the initial comment or question that the creator posed, or as the blog expands, to respond to other users' comments and questions. There are a number of reasons that blogging may be more attractive than verbal discussion in the classroom: 1) the accessibility of the discussion on the web; 2) the extension of discussion beyond the classroom walls; 3) the ability to type responses rather than speak them; 4) the opportunity to reflect before responding within the discussion (Meyer, 2003), 5) the ability to see the prior responses in permanent form and refer back to them; and 6) the added benefit of forming "online communities." Blogs can be used in the classroom as a supplement rather than a replacement to in-class discussion.

Blogs can be used to extend classroom lessons and provide opportunities for independent work. Allowing for blogging after class hours provides the teacher with more flexibility with class time, allowing for discussions to flow naturally (Hendron, 2008). Blogs have great potential for collaboration and can be an ideal forum for social communication in a less threatening environment. Blogs are easy to learn and provide an engaging environment for our learners (Cassell, 2002).

Applications of Blogs in the classroom. One specific application of blogs is to have students use blogs to express themselves in written format. When writing in a blog, students work on literacy skills as they become "authors" of their text. Blogs lend themselves to both factual writing and creative writing. A class of students could write an autobiography within the context of a blog as they learn about each other and comment and question within the blog. Teachers can post questions for students to answer; possibly posting bonus questions on classroom content that can be further discussed the next day in class (Hendron, 2008).

Blogs can easily be used across disciplines. Writing should not be associated only within the context of English Language Arts (ELA), but across the scope of curriculum areas (Huffaker, 2004).

For example a blog could be created in which a student writes about what it was like to live in colonial times while studying that era in social studies class. Other students can respond to that blog by commenting and asking questions. Students could even take on various roles or personas while blogging such as being a young boy or girl during colonial times. This allows for a dynamic exchange of ideas that may be more highly engaging to the students than simply discussing the topic from text within the classroom. See Table 6 for an example of how this type of application is aligned with the TPACK (2012) framework.

Table 6. Sample of the interrelation between tablet computers and TPACK (2012) framework. Technology should be considered as Blogs throughout

Major Subject	Content	Pedagogy
Social Studies	Colonial America	*Pre-teaching Blog*: Teacher posts a question: "Why might Europeans come to America?" Followed up by asking, "What do you know about the colonists?" The teacher moves through the unit, using a variety of technology tools (i.e., videos, testimonials from native Americans delivered via IWBs, drawings of what America looked like during this era). *Post-teaching Blog*: At the end of the unit, the teacher asks the same questions, requiring students to provide substantive responses with supportive evidence, using any digital tool or medium.

UDL vignette. Jenna is in the fifth grade. Similar to her peers, she loves any activities related to using technology. She does not perform well on traditional paper and pencil tasks (i.e., spelling tests, multiple choice exams, etc.). Her teacher announces that they will begin a social studies unit on colonial America. She likes costumes and finds the clothing of the era interesting. Prior to starting the unit, her teacher announces that she will be giving a pretest. Given her difficulties with paper and pencil examinations in the past, Jenna begins to worry…

Jenna's teacher announces that the pretest on colonial America will be provided by way of a blog. She posts questions as the facilitator (see Table 8), and requires all students to provide a response.

There are no grades, and some of the answers are very interesting to Jenna's teacher, guiding the direction and level of emphasis for instruction on particular aspects of colonial America. She moves through the unit using a myriad of interactive activities (i.e., face-to-face play with costumes, recording of vignettes in small groups using tablets, a debate on a discussion board, and a service activity). At the end of the unit, she provides students with the same blog requirement. This time, she provides a grade. Jenna, along with all students, enjoyed the entire unit. Jenna ultimately earned a 95 on the post blog activity and reported to have most enjoyed the in-class play.

By considering Jenna's strengths, weaknesses, and interests as one student in the class, while simultaneously considering learning styles of the other students in the class, her teacher pre-planned a highly successful unit. Of note, even though Jenna, similar to her peers in the class, loves technology, she self-reported that her most favorite activity was the in-class play. By adopting the principles of UDL, students were afforded multiple means of engagement (i.e., service project, in-class play, vignettes), representation and expression (i.e., use of paper and pencil tasks, blogs, tablet activities). Ultimately, this entire unit was a great success for all learners in the class.

VoiceThread

Understanding VoiceThread. VoiceThread is a cloud-based software product which utilizes Adobe Flash (www.voicethread.com). Using *VoiceThread*, teachers and students can

create multimedia files (i.e., presentations, videos, sound files, and documents) for use in a collaborative group. Individuals within this group may participate in a topic-oriented discussion regarding the particular multimedia file in question. Methods of virtual discussion include text, voice, and video. *VoiceThread* files may be kept private or made public. The platform launches into a customizable homepage.

As an interactive multimedia tool, participants are able to hold virtual conversations focused around an easily presentable topic (i.e., shapes). This online tool is easily accessible, easily customized, and cost-effective, yielding it as a product which can be easily utilized by teachers in the 21st century classroom for multiple means of student engagement (Brunvand, and Byrd, 2011). Educators, irrespective of discipline (i.e., general education, special education, speech) may use VoiceThread to address both specific needs of students and general needs of the curriculum.

Virtual 'settings' in VoiceThread may be one-to-one, small group or large group. In addition, the *pace* of student participation may be individualized; an important feature to educators and students is that comments (irrespective of form) are archived.

Applications of VoiceThread in the classroom. Brunvand and Byrd (2011) present applications of Voicethread in the K-12 learning environment within the domains of language arts, science, mathematics, and social studies. In the area of language arts, prewriting skills may be facilitated using VoiceThread. Presenting students with a picture, and brainstorming an outline could lay the foundation for later, more focused writing on a particular topic. In the area of science, students may be able to view a short video on the life cycle of a frog. At particular points in the video, students may be prompted to answer a question, make a comment, and/or doodle on the image.

In the area of mathematics, teachers can upload a static document (i.e., *MS Word* document) to essentially function as a worksheet. Students may be prompted to use the doodle or audio comment function to work through a mathematical equation, and/or provide a rationale for their particular response.

Finally, in the area of social studies, teachers may devise an activity based on multiculturalism, presenting videos on different cultures, and asking a variety of questions, focused on ethnic diversity, critical thinking, and fact recall. See Table 7.

UDL vignette. Nicole is in the fourth grade. She loves peanut butter, chocolate, and bread. In her health class, she is learning about the five food groups, making healthy choices, and living well. She is very shy, slightly overweight, and painfully aware of this. She is not alone.

Table 7. Sample of the interrelation between tablet computers and TPACK (2012) framework. Technology should be considered as *VoiceThread* throughout

Major Subject	Content	Pedagogy
Health	Nutrition	Students can self-report their food intake for the day, comparing and contrasting how their food choices parallel the five main food groups (fruits, grains, vegetables, protein, and dairy).
	Exercise	Students can report on their own level of physical activity, by posting pictures on *VoiceThread* during the specific activity, and reporting on duration and intensity of their workout.

Nicole's health teacher, having had a history of childhood obesity, understands Nicole's struggle, as well as similar struggles of her peers. She created a *VoiceThread*, as a risk free environment, where students were required to report their food intake for one meal on one day, and b) categorize this intake according to the five food groups. There was no requirement to discuss quantity of intake, in an effort to minimize student embarrassment. At first, Nicole was hesitant to respond, but after seeing the *VoiceThread* responses of other students, she was able (and willing) to post her food intake for this one meal. She even responded to a peer with words of encouragement, sharing her own challenges with making healthy food choices.

Nicole's teacher, having considered how emotionally charged this topic may be for some learners, created a learning environment in which students were able to engage in a dialogue with their peers. By using *VoiceThread*, there was an increase in social presence, which Nicole's teacher had not seen in the past (when she had conducted this lesson in a traditional face-to-face format). By affording students with an alternative means of engagement, they were all more willing to take risks, thereby more readily embracing the objective of the lesson.

Collectively, tools such as wikis, blogs, and *VoiceThread* have much to offer students who enter the 21st century classroom. When utilized to facilitate acquisition of novel curriculum content, these tools afford all students with opportunities to capitalize on their strengths, by way of multimodality means of expression, representation, and engagement.

Furthermore, by preplanning lessons, considering learning styles, strengths and weakness of all learners in the classroom, and maintaining a present inventory of technology options available, teachers are essentially upholding the TPACK framework (Vanderlinde and Van Braak, 2013; Mishra and Koehler, 2006). Finally, these tools may not be mutually exclusive. That is, both teachers and students may interface multiple tools and platforms depending on their educational needs. We now turn our discussion to hybrid learning.

Hybrid Learning

Understanding Hybrid Learning. Through the use of technology, the 21st century classroom now transcends beyond the physical classroom walls. Traditional face-to-face methods of teaching are now being replaced with distance learning, which may take the form of either fully online or blended learning. Online learning is defined as a form of education in which both instruction and content are provided to students primarily via the internet (iNacol, 2011; US Department of Education Office of Planning, Evaluation, and Policy Development Policy and Program Studies Service, 2010). Online learning is frequently synonymous with the terms such as e-learning, cyber-learning, and virtual learning (iNacol, 2011). An example of online learning would be to view a lecture presented over the internet then to provide students with links to interactive activities for online submission. The teacher can subsequently provide either written, audio, or video feedback to students in addition to providing a grade. Blended learning is defined as a minimum of 30% and a maximum of 70% of online teaching (iNacol, 2011; Allen, Seaman, and Garrett, 2007). This term is often synonymous with hybrid learning. While blended learning is not necessarily new, the notion that this form of engagement can *better* facilitate student learning certainly is.

Blended teaching has the potential to expand the learning process beyond the traditional class meeting. Blended learning, therefore, may facilitate the formulation of a community of inquiry, by fostering interpersonal skills across different forms of media through a common curriculum (Garrison, Anderson, and Archer, 2000). This fluid boundary between face-to-face and online interaction should ideally afford students with a more meaningful educational experience. Of note, social presence is designed to facilitate a climate of risk-free and open communication (Garrison and Vaughan, 2008). During students' educational experiences, activities for purposeful, goal oriented interaction may be designed to meet curricular objectives using blogs, wikis, multimedia tools, and discussion boards. One specific form of blended learning is the 'flipped classroom' approach to hybrid teaching (Topp, 2011). A flipped classroom is one in which the teacher provides lectures/tutorials for students to review online. The in-seat classroom time is then spent on engaging in meaningful process activities which highlight the points provided in the online lectures (which students will have viewed prior to arriving to school).

Psycharis, Chalatzoglidis, and Kalogiannakis (2013) investigated the role of e-learning as an instructional tool in the area of physics. More specifically, the objective of Psycharis and colleagues (2013) was to instruct students on electric circuits using a popular e-learning platform called the Modular Object-Oriented Dynamic Learning Environment (i.e., *Moodle*) (Hargadon, 2008). Using *Moodle* as an instructional tool, students individually responded to specific questions, became involved in cooperative on-line activities, and made predictions based on teacher directed "problems" with electric circuits.

Both discussion boards and the glossary feature were further utilized to facilitate mastery of electric circuits. The unit culminated in a questionnaire regarding physics concepts *and* student perceptions of the e-learning method. Students' overall responses were positive regarding use of *Moodle* for learning concepts in physics (Psycharis, Chalatzoglidis, and Kalogiannakis, 2013). This study, in addition to the authors' teaching experiences, supports the use of *Moodle*, particularly for online discussion.

The aforementioned web 2.0 applications (i.e., wikis, blogs, *VoiceThread*) may be utilized in either online or blended learning environments. The *Moodle* format supports both inquiry- and discovery-based approaches to learning in an on-line environment, with options for collaborative learning (Brandl, 2005). An example of one built-in feature of *Moodle* is the *Glossary Module*, which can facilitate vocabulary acquisition. Using this module, teachers are able to collaborate with students to develop topic-based dictionaries. The teaching options for hybrid teaching and learning are vast. See Table 8.

UDL vignette. Michael is a high school senior. He has difficulty attending to any particular task for extended periods. More specifically, Michael has difficulty sitting in class for more than ten minutes. At home, Michael has difficulty managing his free time. He will usually look up videos on *YouTube* or play games on his laptop.

Michael's health teacher is quite tuned in to the fact that Michael has difficulties with attending to tasks. She also knows that other students in the class favor either in-seat traditional lecture or using technology. She decides, from the beginning, to design a class using hybrid teaching and learning. Using *Moodle*, Michael's teacher posts a (controversial) video about addiction in college. She then breaks up the class into debate groups for online discussion, using the discussion board feature in *Moodle*. She assigns a facilitator for each group, with a fact-based guide, and posts rubrics specifying her expectations.

Table 8. Sample of the interrelation between tablet computers and TPACK (2012) framework. Technology should be considered as hybrid (online and face-to-face) teaching and learning

Major Subject	Content	Online Pedagogy	Face-to-Face Pedagogy
Health	Reproductive System	Interactive drag and drop activity for picture identification.	Students work in groups to narrate process of egg fertilization.
	Addiction	Teacher posts controversial video for review online.	Students are broken into two groups to debate the issue.

Once complete, the class comes together within the physical walls of the classroom, to review the process they just experienced and discuss the emotional components of the controversial video. This instructional delivery format was ideal for Michael, since he was able to shift from face-to-face (i.e., in-seat time) to online activities easily; his challenges in attention were no longer inhibiting his success with this task or in this class. In fact, he responded and commented regularly, sharing honest responses and was a valuable participant in the overall learning process.

By providing opportunities for multiple means of expression through the various methods of responding, the teacher was able to capture and hold Michael's attention. The focus on collaboration represents the engagement suited to Michael's learning needs.

CONCLUSION

The 21st century classroom may be described as an interactive, technology-rich learning environment. Embracing this idea requires educators to shift their thinking from more traditional methods of curriculum delivery, to inclusion of technology, as appropriate, for all learners. The underlying notion however, is that content still must remain teacher-facilitated, pre-planned, and efficiently executed. Using the principles of TPACK (Vanderlinde and Braak, 2013; Mishra and Koehler, 2006) and Universal Design for Learning (Edyburn, 2013; McGuire, Scott, and Shaw, 2006; Spencer, S., 2011) for *all* students, will ultimately maximize student outcomes and allow all students to access the curriculum. More specifically, the objective of the 21st century classroom is to make learning engaging while addressing student strengths, thereby perpetuating student motivation to embrace the process of learning. As many of our 21st century learners have been raised on technology, it is important to incorporate technology in our teaching in a meaningful way to maximize our students' outcomes.

Embracing the notion that there is an interrelationship between content, pedagogy, and technology is inherently the description of the TPACK frame of reference (Mishra and Koehler, 2006). A common thread throughout this chapter has been the incorporation of various technology tools (e.g., laptops, tablets) in conjunction with curricular objectives (e.g., science and social studies). In doing so, not only do students engage with current methods of learning, but they further stand to increase social presence both online and in face-to-face learning environments.

Of note, the technology tools highlighted in this chapter are not an exhaustive list, but rather a starting point for educators who are looking to initially develop their classrooms for the 21st century learner, or to further enhance the classroom of those educators who are already embracing the 21st century classroom. The purpose of this chapter is to provide a demonstration of how these technology tools may be used to maximize a UDL environment for all students across curriculum areas. However, additional tools (not discussed in this chapter) may also be utilized. For example, incorporating *YouTu*be videos into a lesson using an interactive whiteboard may be another inclusion of a technology tool. With respect to the UDL framework, allowing students to utilize the closed caption feature on *YouTube* (as they wish) would be another example of multiple means of representation. An additional example would be including audio feedback in a *Microsoft Word* document so that a printed image could be paired with an auditory representation of the same material. This may circumvent a child's challenges with reading text.

In summary, we must always keep in mind that students need to be actively engaged in order for learning to be fun, engaging, instructional, and successful. Simply using technology in the classroom with our students is not enough. Teachers still need to clearly plan, effectively execute, and continually monitor their lessons. Anyone can use technology in their classroom, but the key is to use it effectively in relation to the goals for learning. Technology used can provide multiple means of representation, multiple means of expression and multiple means of engagement. That said, when these processes are undertaken and technology is appropriately incorporated, students in the 21st century classroom could benefit greatly.

REFERENCES

Allen, I. E., Seaman, J. and Garrett, R. (March, 2007*). Blending In: The extent and promise of blended education in the United States*. Retrieved October 8, 2008 from http://sloan consortium.org/publications/survey/pdf/Blending_In.pdf.

Allison, P. (2005). *High school students (and teachers) write collaboratively on a wiki.* Retrieved December 3, 2013 from www.nycwp.org/paulallison/2005/12/04#a149.

Bechina, A. and Kramer, B. (2013). Editorial: Knowledge, social media and technologies for a learning society. *Journal of integrated Design and Process Science,* 17(1), 1-3.

BECTA (2006). *Teaching interactively with electronic whiteboards in the primary phase*. Retrieved December 3, 2013 from http://publications.becta.org.uk/download.cfm?resID= 25918.

Brandl, K. (2005). Are you ready to "Moodle"? *Language Learning and Technology,* 9(2), 16-23.

Brunvand, S. and Byrd, S. (2011, March/April). Using VoiceThread to promote learning engagement and success for all students. *Teaching Exceptional Children,* 28-37.

Carr, A., Jonassen, D., Litzinger, M. E., and Marra (1998). Good ideas to foment educational revolution: The role of systematic change in advancing situated learning, constructivism, and feminist pedagogy. *Educational Technology*, 38(1), 5-15.

Cassell, J. (2002). "We have these rules inside": The effects of exercising voice in a children's 0nline forum, In: S. Calvert, A. Jordan and R. Cocking (editors). *Children in the Digital Age: Influences of Electronic Media on Development*. Westport, CT: Praeger.

Clarke, B. and Svanaes, S. (2012) One-to-one tablets in secondary schools: An evaluation study. Stage 1 2011; 2012. 4 December 2012, *Tablets and Schools* http://www.tabletsforschools.co.uk/wp; content/uploads/2012/12/2011;12;Final;Report.pdf. Last accessed: Jan. 7, 2014.

Cogill, J. (2003). The use of interactive whiteboards in the primary school: Effects on pedagogy. *ICT Research Bursaries*, 52.

Couse, L. J. and Chen, D. W. (2010). A tablet computer for young children? Exploring its viability for early childhood education. *Journal of Research on Technology in Education,* 43(1), 75-98.

Culligan, M. (2003). Digital natives in the classroom. In: B. Hoffman (Ed.). *Encyclopedia of Educational Technology*. Retrieved from http://www.etc.edu.cn/eet/articles/digitalnatives/index.htm.

Edyburn, D. L. (2013). Critical issues in advancing the special education technology evidence base. *Exceptional Children,* 80(1), 7-24.

Ekhami, L. (2002). The power of interactive whiteboards. *School Library Media Activities Monthly,* 18(8), 35-38.

Ferris, S. P. and Wilder, H. (2006). Uses and potentials of wikis in the classroom. *Innovate: Journal of Online Education*, 2(5), 5.

Fessakis, G., Gouli, E. and Mavroudi, E. (2013). Problem solving by 5-6 years old kindergarten children in a computer programming environment: A case study. *Computers and Education,* 63, 87-97.

Garrison, D. R., Anderson, T. and Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, 2(203), 87-105.

Garrison, R. and Vaughan, N. D. (2008). *Blended Learning in Higher Education: Framework, Principles, and Guidelines*. San Francisco, CA: Jossey-Bass.

Glover, D. and Miller, D. (2001). Running with technology: The pedagogic impact of the large-scale introduction of interactive whiteboards in one secondary school. *Journal of Information Technology in Childhood Education,* 1, 257-275.

Groff, J. and Mouza, C. (2008). A framework for addressing challenges to classroom technology use. *Association for the Advancement of Computing in Education Journal,* 16 (1), 21-46.

Hargadon, S. (2008). Unlock the web with open source. *School Library Journal,* 54 (12), 19.

Henderson, S. and Yeow, J. (2012). IPads in Education - A case study of iPad adoption and use in a primary school. *HICSS '12 Proceedings of the 2012 45th Hawaii International Conference on System Sciences.*

Hendron, J. G. (2008). *RSS for educators.* Washington, DC: International Society for Technology in Education.

Higgins, S., Beauchamp, G. and Miller, D. (2007). Reviewing the literature on interactive whiteboards. *Learning, Media and Technology*, 32(3), 213-225.

Huffaker, D. (2004). The educated blogger: Using weblogs to promote literacy in the classroom. *First Monday*, 9(6).

Inan, F. A. and Lowther, D. L. (2010). Laptops in the K-12 classrooms: Exploring factors impacting instructional use. *Computers and Education*, 55(3), 937-944.

International Association for K-12 Online Learning [iNacol]. (2011). *The online learning definitions project*. Vienna, VA: Author.

Jewitt, C. (2005). Multimodality, "reading", and "writing" for the 21st century. *Discourse: studies in the cultural politics of education*, 26(3), 315-331.

Johnson, C. (2002). The writing's on the board. *Educational Computing* and *Technology,* 58-59.

Kress, G. (2003). *Literacy in the new media age*. NY, NY: Routledge.

Lacina, J. (2009). Technology in the classroom interactive whiteboards: Creating higher-level technological thinkers? *Childhood Education,* 85(4), 270-272.

Lantham, P. (2002). Teaching and learning primary mathematics: The impact of interactive whiteboards. *North Islington Education Action Zone: BEAM research papers*. Available at https://global.oup.com/education/content/primary/series/beam/?region=international.

Leuf, B. and Cunningham, W. (2001). The Wiki way: Quick collaboration on the web, *Reading*, MA: Addison Wesley.

Levy, P. (2002). Interactive whiteboards in learning and teaching in two Sheffield schools: A developmental study. *Sheffield Excellence in Cities Partnership.* Sheffield, Department of Information Studies, University of Sheffield.

Manny-Kan, E., Dagan, O., Tikochinski, T. B., and Zorman, R. (2011). Using the interactive white board in teaching and learning - An evaluation of the SMART CLASSROOM pilot project. *Interdisciplinary Journal of E-Learning and Learning Objects. IJELLO Special Series of Chais Conference 2011 best papers,* 7, 249-273.

McGuire, J., Scott, S. and Shaw, S. (2006). Universal design and its application in educational environments. *Remedial and Special Education,* 27,166-175.

Meyer, K. A. (2003). Face-to-face versus threaded discussions: The role of time and higher-order thinking. *Journal of Asynchronous Learning Networks*, 7(3), 55-65.

Mitchell, S. (2008). Toolbox-Easy wiki hosting, Scott Hanselman's blog, snagging screens. *Microsoft Developer Network Magazine*, 11.

Mishra, P. and Koehler, M. J. (2003). Not "what" but "how": Becoming design-wise about educational technology. In: Y. Zhao (Ed.), *What teachers should know about technology: Perspectives and practices* (pp. 99-122). Greenwich, CT: Information Age Publishing.

Mishra, P. and Koehler, M. J. (2006). Technology pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record,* 108(6), 1017-1054.

Moseley, D., Higgins, S. and Bramald, R. (1999). *Ways to forward with ICT: Effective pedagogy using information and communications technology in literacy and numeracy in primary schools.* Newcastle, England: Newcastle University.

National Science Teachers Association (1999). Toshiba/NSTA laptop learning challenge. Retrieved from http://www.nsta.org/publications/interactive/laptop/index.htm.

Norris, C. A. and Soloway, E. (2011). Learning and schooling in the age of mobilism. *Educational Technology*, November-December, 3-10.

O'Reilly, T. (2005). *What is web 2.0: Design patterns and business models for the next generation of software*. Retrieved from http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html.

Prensky, M. (2011). *From digital natives to digital wisdom. Hopeful essays for 21st century learning.* Thousand Oaks, CA: Corwin Press.

Psycharis, S., Chalatzoglidis, G. and Kalogiannakis, M. (2013). Moodle as a learning environment in promoting conceptual understanding for secondary school students. *Eurasia Journal of Mathematics, Science and Technology Education,* 9(1), 11-21.

Quillan, I. (2011). Educators evaluate learning benefits of iPad. *Education Week,* 4(3), 38, 40-41.

Richardson, W. (2006). *Blogs, wikis, podcasts, and other powerful web tools for classrooms*. Thousand Oaks, CA: Corwin Press.

Rowe, M., Bozalek and Frantz, J. (2013). Using Google Drive to facilitate a blended approach to authentic learning. *British Journal of Educational Technology,* 44(4), 594-606.

Siegle, D. (2010). Cloud computing: A free technology option to promote collaborative learning. *Gifted Child Today,* 33(4), 41-45.

Smith, H., Higgins, S., Wall, K., and Miller, J. (2005). Interactive whiteboards: Boom or bandwagon? A critical review of the literature. *Journal of Computer Assisted Learning*, 21, 91-101.

Spencer, S. (2011). Universal design for learning: Assistance for teachers in today's inclusive classrooms. *Interdisciplinary Journal of Teaching and Learning,* 1(1), 10-22.

Turel, Y. K. (2010). Developing teachers' utilization of interactive whiteboards. In: D. Gibson and B. Dodge (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2010*, Chesapeake, VA: AACE. (pp. 3049-3054).

Turel, Y. K. and Demirli, C. (2010). Instructional interactive whiteboard materials: Designers' perspectives. *Procedia Journal of Social and Behavioral Sciences,* 9, 1437-1442.

Topp, G. (2011, October 6). Flipped classrooms take advantage of technology [Electronic Version]. *US Today*.

US Department of Education Office of Planning, Evaluation, and Policy Development Policy and Program Studies Service (2010). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies.* Washington, DC. Retrieved on September 17, 2013 from http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf.

Vanderlinde, R. and Van Braak, J. (2013). Technology planning in schools: An integrated research-based model. *British Journal of Educational Technology*, 44, (1), E14-E17.

Walser, N. (2008). Teaching 21st century skills. *Harvard Education Newsletter,* 24(5), 1-8.

Wang, S. K., and Hsu, H. Y. (2008). Reflections on using blogs to expand in-class. *TechTrends*, 52(3), 81-85.

Zhu, E., Kaplan, M., Dershimer, R. C., and Bergom, I. (2011). Use of laptops in the classroom: Research and best practices. *Center for Research and Learning,* 30, 1-6.

N.G.