Chapter 6
Augmented Learning with Augmented Reality

Susan Herrington Kidd and Helen Crompton

Abstract Perhaps no other digital technology has the potential for revolutionizing the educational experience as augmented reality (AR). In this chapter the philosophical, pedagogical, and conceptual underpinnings are unpacked regarding learning with AR. Specifically, AR is defined and the evolution detailed. Next, some of the common usages of the technology are described, recommendations given, and finally the future educational implications are presented.

6.1 Introduction

Perhaps no other digital technology has the potential for revolutionizing the educational experience as augmented reality (AR). AR is an interactive technology which applies computer-generated information to incorporate detailed information about locations or activities from the real world (Yuen et al. 2011). In this chapter the philosophical, pedagogical, and conceptual underpinnings regarding learning with AR are unpacked. Specifically, AR is defined and the evolution detailed. Next, some of the common usages of the technology are described, recommendations given, and finally the future educational implications are presented.

For some, AR is considered to be the realm between reality and virtual reality where countless educational opportunities exist (Pasaréti et al. 2011). For example, in New Zealand at the Arts Center of Christchurch, visitors are exposed to an AR experience as they walk down into the basement room. As they enter the room, they hear a voice of a man telling them to "Come closer into the darkness." As the visitor moves forward, a life-sized 3D image of an old man appears to be floating in front of where they stand. This man explains what it was like working in that dark place a

S.H. Kidd (✉) · H. Crompton
Old Dominion University, Norfolk, VA, USA
e-mail: Susanherringtonkidd@gmail.com

H. Crompton
e-mail: Crompton@odu.edu

D. Churchill et al. (eds.), *Mobile Learning Design*, Lecture Notes in Educational Technology, DOI 10.1007/978-981-10-0027-0_6

100 years ago. This old man is a virtual image of Ernest Rutherford, New Zealand's Nobel Prize winning physicist who performed his initial research as an undergraduate at the University of Canterbury. Through the use of AR, the empty room is turned into a unique learning experience (Billinghurst 2002). In the past 5 years, AR applications have become increasingly more portable and available through mobile devices (Yuen et al. 2011). The availability and portability of AR can provide students with on-the-spot access to multi-sourced, location-specific information which will foster continuous and universal instruction (Yuen et al. 2011).

6.2 Defining Augmented Reality

AR is a 3D technology that fuses the physical and digital world in real time (Pasaréti et al. 2011). In other words, digital information, such as text, images, and video are layered and blended into our perception of the real world (Yuen et al. 2011). AR differs from virtual reality in that AR permits the user to view the real world while simultaneously viewing the virtual layered imagery (Billinghurst 2002); virtual reality provides a digitalized representation of the real world. AR is typically utilized and viewed through either a handheld or head-mounted display unit. These handheld and head-mounted units can be used outside the classroom, thereby eliminating the need for instruction to be limited to a specific environmental context.

AR is unique in comparison to other computer interfaces as it can be used to embellish real-world experiences, as opposed to simply separating the user from the real world and thrusting them into a virtual reality (Billinghurst 2002). These augmentations enhance an individual's perception and comprehension of what is occurring around them (Yuen et al. 2011). The additional over-laid information flows smoothly together as one visual, not appearing incongruous to the user (Yuen et al. 2011).

6.3 Evolution of Educational Augmented Realty

Educational technology is a rapidly growing and evolving field. Schools today must prepare their students for a society that does not currently exist. As the world becomes increasingly complex, this becomes more and more difficult (Ohidi 2006). Ivan Sutherland created one of the first head-mounted 3D displays in 1968, projecting a rudimentary framed graphical image into a room (Caudell and Mizell 1992). Tom Caudell, an engineer working for Boeing in 1992, designed a method that could display cables and other parts of the aircraft, virtually, without having to remove the shield of the machine (Caudell and Mizell 1992). Applications were later developed that housed entire interactive translucent screens providing airmen with basic flight information (Pasaréti et al. 2011). AR first appeared for the average consumer during a live sporting broadcast on television as the country's flag could be seen over the video of a sporting victory (Pasaréti et al. 2011).

In the last 5 years, various new headsets have been made available to the public. Google Glass is a type of Augmented Reality device worn on a spectacle type frame. As the user wears the Google Glass, they can see in their top right field of vision a small screen that provides text feedback to verbal commands or tapping and swiping the frame. Microsoft is advertising the Hololens that claims to enable you to operate various computer programs, such as email and calendar, while viewing them in real-world environments. For example, your calendar could appear over your fireplace so you could check your schedule for the day.

The majority of headsets work with mobile phones that are slotted into the headset. Cases are purchased for the headset to match the particular brand and version of the phone. The user can download various VR applications to view with the headset; some of these are specific to the headset and others can be accessed via multiple devices. At the time that this chapter was written, there are four main headsets available to the public; Occulus Rift, VR One, Poppy3D, and Google Cardboard. The *Occulus Rift* can be used for playing immersive games and VR movies. At the end of 2014, the *VR One* was available with opportunities to take 3D sightseeing tours to famous destinations and tour VR museums. The Occulus Rift and VR One offer 360° × 360° vision. Therefore, you can turn to your left or right in a complete circle to look all around you, and you can also look up at the sky and down at the floor.

AR devices can be expensive for whole class one-to-one purchases. For this reason, other solutions have been made available. The *Poppy3D* provides 360° × 360° experiences and the ability to record video in one direction. Nonetheless, the cheapest option at this time is to purchase *Google Cardboard*. As the name suggests, this is a cardboard headset with a Velcro panel access to place your phone. Using Google Cardboard some 360° × 360° experiences can be gained; however, the quality does decrease to match the decrease in the cost of the headset.

6.4 Augmented Reality in Education

Technology has changed the way people work and socialize. A new generation of students has emerged, who fully engage in the technological affordances available. These technologies are seeping into educational practice as Sharples (2005) describes:

> Every era of technology has, to some extent, formed education in its own image. That is not to argue for the technological determinism of education, but rather that there is a mutually productive convergence between main technological influences on a culture and the contemporary educational theories and practices. (p. 147)

Pedagogies are also changing due to pressure from educators and governments advocating for educational reforms to utilize these technologies for educational purposes (Common Core State Standards Initiative 2010; Greenhow and Robelia 2009; Jonassen et al. 2008).

AR technology has matured to the point where it can be applied to a much wider range of application domains and education is an area where this technology could be especially valuable (Billinghurst 2002). An educator's vision of omnipresent learning could become a reality with AR, as students are able to access a vast array of location-specific information that has been assembled and supplied by an assortment of resources (Yuen et al. 2011). However, AR experiences must be aligned with the student's interests if they are to be educationally effective (Bujak et al. 2013).

6.4.1 Educational Affordances

Using AR in K-12 can provide many pedagogical affordances (Billinghurst 2002; Klopfer 2008) as AR can engage, inspire, and induce students to explore educational concepts from different perspectives (Kerawalla et al. 2006). As students use the AR they are connected to a very stimulating multi-sensory experience. Learning is hightened as the students engage in hands-on manipulation of materials and handle the acquired knowledge in a new and interactive fashion (Wu et al. 2013).

Additionally, researchers have worked to implement AR within those educational genres which have historically proven difficult for students to acquire real-world, first-hand experience, such as physics and astronomy (Lee 2012). AR technologies enable students to take greater control of the speed and direction of their education, while also generating a genuine educational atmosphere conducive to individuals with diverse learning styles (Hamilton and Olenewa 2010). In today's schools, educators are requiring students to be critical consumers of knowledge and not passive learners focused on memorization. Klopfer and Yoon (2004) found that AR can be used to develop active learners as it can be used to develop and enhance critical twenty-first century IT skills.

It is suggested that the role-playing intrinsic to the AR experience may result in an increased sense of confidence and efficacy relative to the field of study (Wasko 2013). While partaking in virtual activities and by learning to assume virtual personas, students can learn to separate themselves from negative self-concepts which could potentially hamper their education (Steinkuehler and Williams 2006). Dede (2008) posits that students show an increased ability to apply what they learn into a variety of scenarios including both AR activities and real-life situations (Yuen et al. 2011).

Motivation is a reported benefit as students' attention is maintained throughout the class and students reach higher levels of participation in educational activities with less cognitive efforts (Di Serio et al. 2013). Students reported that using AR programs increased their motivation for learning, made them feel more like active investigators, increased their interest in the physical settings and content of the experience, and helped them view issues from multiple vantage points (Wasko 2013).

The instructional practice AR provides is unique for three main reasons; it offers seamless interaction between real and virtual environments, it facilitates a tangible interface metaphor for the handling of items, and it offers a smooth shift between reality and virtually (Billinghurst 2002).

6.4.2 Learning with Others

Billinghurst (2002) conducted studies on collaboration and AR. These are findings come from that work. Within the classroom, students' collaborative work efforts improve when they are utilizing a shared workspace. However, this proves difficult to accomplish when working on computer-based instruction. Inkpen (1997) postulates that students' achievement improves when they are crowded around a solitary computer, as opposed to working on individual machines. Group communication patterns also change when students are seated in front of one computer compared to when students have an open communication space between them such as at a worktable. Students alter their gaze, mannerisms, and other nonverbal actions when they are no longer facing each other around a workspace, but instead sitting side-by-side in front of a joint computer workstation. The use of AR allows students to be seated in a round table fashion, while simultaneously situated around the virtual image. Billinghurst found that AR marries the desired group communication patterns of students seated around a joint workstation, with the instinctively physical collaborative nature of students in front of a solitary computer. The end result is an authentic conversation through technology.

6.4.3 Tangible Interface Metaphor

To express understanding in an instructional environment, tangible items are often used. In a collaborative setting, these tangible items are utilized to launch a shared understanding (Gay and Lentini 1995). Billinghurst (2002) found that the relationship between virtual and tangible items is very personal in AR and these tangible items can be embellished in ways that are impossible in traditional settings. The advantage is that students with little to no technology experience will still enjoy a fulfilling interactive experience.

6.4.4 Transition

The extent to which the user's world is digitally created can be used as the defining range on a visual spectrum of computer interactions (Milgram and Kishino 1994). Virtual imagery increases and the level of interaction with reality decreases, moving from the left to the right on the spectrum (Billinghurst 2002). This spectrum illustrates how AR technology can be transitioned from being introduced to gradually increasing virtual depth.

6.5 Augmented Reality Programs for Education

AR programs could potentially enhance a myriad field of study, from geometry lessons, to 3D representation of cells in biology, to displaying molecular structure in chemistry, and simulating a sport in physical education (Pasaréti et al. 2011). AR allows any subject to become more vibrant, appealing, and interactive (Pasaréti et al. 2011). Educational AR games and AR books are two such platforms.

6.5.1 AR Educational Gaming

Games are routinely used in the classroom to facilitate instruction in concepts that are confusing or complicated (Yuen et al. 2011). AR technology has the potential to assist educators by presenting difficult information, associations, and relationships in alternative ways (Yuen et al. 2011). Educational AR games insert a layer of information which augments 'users' experience of reality (Klopfer and Squire 2008, p. 205). This is often accomplished through handheld devices. Klopfer and Squire refer to these AR applications as "augmented reality educational gaming" (2008, p. 203). This layer of information connects the learner to a particular place, location, or time. Educators are then able to manipulate this technology for instruction in specific geographic locations, events in history, or science and mathematical concepts (Klopfer and Squire 2008). Some of the most common examples of AR gaming involve smart-phone applications which incorporate GPS information, effectively connecting real-world information and virtual images (Yuen et al. 2011).

6.5.2 Augmented Realty Books

AR books may very well be the books that close the gap between the digital and physical world and AR books can offer a vital conduit for students because through the use of AR gear, users are able to experience three different levels of reality while utilizing an interactive AR story book (Yuen et al. 2011). In the first level, a simple book could be utilized collaboratively by several users while actually holding and using the book itself. In the second level, several users could view 3D or animated-added AR content in an AR pop-up book. In the third level, AR gear is used to allow users "to 'fly' or 'teleport' into the 3D environment produced by the book, and then participate in the story as it unfolds, interacting with virtual objects, characters, or even other 'readers'" (p. 132). This is the moment when users no longer exist in the real world, but have transitioned to acting within a virtually augmented, real-world setting and then become completely engrossed in an interactive and wholly virtual setting (Yuen et al. 2011).

Digital native students are attracted to the 3D appearance and interactive activities that AR brings to the educational activities (Yuen et al. 2011). When these 3D appearances and interactive activities are melded with literacy, as in the AR book, *"The Future is Wild: The Living Book,"* developed by Meatio in Germany and launched at the Frankfurt Book Fair in 2011, it demonstrates the potential for readers to develop deeper connections in the book (Yuen et al. 2011).

6.5.3 Book Applications

There are various AR books available to the public. The *MagicBook* is an AR book that Lee (2012) described as an enhanced version of a traditional pop-up book. This AR interface system permits AR content to be produced for a traditional book and then brings the story to life with animated and interactive models drawn from the text or illustrations already in the book. Young children can imagine themselves as active participants in a story as the MagicBook brings this dream to fruition using a traditional book as the main interface object. These books remain traditional in every way; turning pages, observing the illustrations, and reading the text without the requirement of any additional technological device. However, with the use of a handheld AR display, readers will now see 3D virtual models projecting from the pages.

ZooBurst is another system which allows students to design their own 3D pop-up books. Storytellers choose one of the books on the Website and then simply hold the ZooBurst marker in front of their Webcam. The on-screen book is entirely interactive and customizable; from arranging characters and props to uploading personalized artwork, to changing the page, clicking on characters to see the dialogue, or tipping the pages in different directions to see it from different angles, audio files can even be recorded. Another AR pop-up book is the *Digilog Books* and when students wear the appropriate eye wear, 3D characters launch from the pages. AR books can be used at the elementary school level to supplement instruction on subjects such as geology; demonstrating the earth's layers, their relationships, differences, and roles (Yuen et al. 2011).

AR books will change the way stories are experienced; commanding increased awareness from the storyteller on an array of concerns, such as the book's structure, value, and immersiveness and "The potential of AR books to appeal to many types of learners, through many paths, is undeniable and exciting for educators" (Yuen et al. 2011, p. 128). These AR interfaced books can change the way students and teachers view and use traditional textbooks. Textbooks no longer need to be stagnant wells of information (Billinghurst 2002). AR can transform the printed page into an avenue with the capacity to transfer students into animated, interactive virtual environments.

6.6 Teaching with Augmented Reality

AR for educational purposes has a foundation in constructivism and situated learning theories (Wasko 2013). Collaborative assignments can be improved through the use of AR (Kesim and Ozarslan 2012). AR can be used to position students outside of the classroom in authentic situations and the capacity to offer learners opportunities to test potential solutions to situations or problems and to explore the outcomes for acceptability (Wasko 2013). The ability to experience these types of issues is not available in our current environment, but through AR we will be able to understand our current environment better (Wasko 2013).

6.6.1 Student-Centered Learning

Today's learners are encouraged to be active, reflective thinkers in the learning process. This cultural and societal pedagogical shift from passive learners to active participants has been driven by reactions to behaviorism, minority rights movements, wider access to education, linguistic pragmatism, and increased internationalism (Gremmo and Riley 1995). With the diachronic pedagogical advancements towards student-centered learning, a concomitant progression can be found in technological affordances manipulated to support those learning philosophies (Crompton 2013). From the discovery learning of the 1970s, to the socio-constructivist learning approach of the 1990s, educators have been working towards designing curriculum and utilizing technologies to enable students to connect with the material and understand the concepts being taught.

With the introduction of AR, educators have been provided with a way to push the boundaries of traditional pedagogies. Components of constructivism are clear within the design of AR learning environments as students are given the opportunity to connect educational concepts to form their own understandings (Wasko 2013). Students can investigate the world around them, learn through their successes and mistakes, and find multiple outcomes. The problem-based style of many of the educational settings, along with the goal of reducing the margins between learning and doing, are evidence of the sway the situated learning theory has within AR learning environments (Wasko 2013). Another key element of this instructional approach is that students experience the augmented version of the reality in the real world, not as an avatar in a virtual world in their computer (Wasko 2013).

Barab and Duffy (2000) posit that once students enter the AR world or "practice fields," teachers' objectives transition from conceptual learning to an authentic educational experience that is very likely to require the use of learned skills or ideas. Students have the opportunity to experience and train for situations or problems without the added risk of injury or mishap, such as natural disasters, hazardous material concerns, or any other task which may be logistically or physically too dangerous to perform in the real world (Wasko 2013).

6.6.2 Designing for Learning

Kirkley and Kirkley (2005) stated that "with advances in computer technologies and networked learning, we have exciting opportunities to design learning environments that are realistic, authentic, engaging and extremely fun" (p. 20). Additionally, with the improvements in required hardware and software, an increased number of students and instructors have the capacity to develop and utilize AR enhanced instructional environments (Wasko 2013). Teachers can now create interactive environments to enhance their lesson plans on everything from specific historical landmarks or locations, specific time periods, or environmental or weather situations like volcanoes or hurricanes which would be exceptionally dangerous to explore first-hand.

Cuendet et al. (2013) report of three things that must be remembered when designing AR learning activities. The first is that the AR system must be flexible enough so that teachers can make necessary adaptations to meet the needs of their students. Second, AR lessons should be the same content size and length as traditional lessons and from the same curriculum. Third, the system must take into consideration the limits of the context.

6.7 The Future of Augmented Reality in Education

While AR technology is not new, its use in education is still in its infancy. In order to determine how to best utilize this technology in the school environment, educators must continue to work with researchers within the field (Billinghurst 2002). Current research suggests that AR technology has potential as a practical extension to textbooks and exercise workbooks, allowing for hands-on experiences to facilitate the lessons (Pasaréti et al. 2011). AR is becoming more commonplace in today's society. The accessibility and affordability of mobile devices and other hardware with the capability to process and display information at rapid speeds has made the potential use of AR possible (Yuen et al. 2011). However, as the tools facilitating AR continue to evolve, so must the research and development of educational AR applications.

Experts reported in the 2015 Horizon Report K-12 Edition that AR as a visualization tool is an important technological development and a way of teaching complex thinking (Johnson et al. 2015). However, additional scaffolding and support would be required to assist educators in developing a suitable instructional framework, identifying possible answers to their issues, and decoding the clues provided by the technological devices and embedded in the real-world environment (Wu et al. 2013). It will become necessary to find instructional designers who can create the learning activities for AR systems in the future (Kesim and Ozarslan 2012).

6.8 Recommendations

As educators consider implementing AR in their educational activities, the following recommendations can help get the most out of the experience.

- Provide multiple opportunities for students to collaborate and share their AR experiences.
- Provide opportunities such as field trips to optimize AR's inherent mobile capabilities.
- Utilize AR as an additional learning platform in conjunction with other visual, auditory, and tactile opportunities.
- Connect AR experiences to educational standards.
- Think outside the box, rather than try to fit AR to a traditional approach.

6.9 Conclusion

AR offers extensive opportunities for educators to create authentic, engaging, and customizable learning experiences for their students (Yuen et al. 2011). The unique affordances of AR have pushed the boundaries of traditional pedagogies to enable educators to provide rich, student-centered, learning experiences. AR technology has the potential to be a powerful remediation and special education tool because of its inherent mobile capabilities. Future researchers may consider how AR programs could be used to help students who struggle with dyslexia or other reading disabilities to read clearly. Perhaps AR programs could be individually designed as a corrective layer for each student's particular reading disability. As AR technologies evolve future researchers could discover new affordances to learning using AR.

This chapter offers researchers, educators, and policy makers' insight into the educational opportunities for AR in K-12 learning. In addition, a set of recommendations are provided to those who seek to employ these methods to enhance learning opportunities. From one of the early AR devices developed by Ian Sutherland in 1968, AR developers have made great leaps in technological advancements. However, AR is only still emerging with many researchers, practitioners, and policymakers eagerly waiting to see what AR learning opportunities will be provided in future years.

References

Barab, S. A., & Duffy, T. M. (2000). From practice fields to communities of practice. In D. H. Jonassen & S. M. Land (Eds.), *Theoretical foundations of learning environments* (pp. 25–55). Mahwah, NJ: Lawrence Erlbaum Associates.

Billinghurst, M. (2002). Augmented reality in education. *New Horizons for Learning, 12*.

Bujak, K. R., Radu, I., Catrambone, R., MacIntyre, B., Zheng, R., & Golubski, G. (2013). A psychological perspective on augmented reality in the mathematics classroom. *Computers & Education, 68*, 536–544.

Caudell, T. P. & Mizell, D.W. (1992). Augmented reality: An application of heads-up display technology to manual manufacturing processes. In *Proceedings of IEEE Hawaii International Conference on Systems Sciences* (pp. 659–669).

Common Core State Standards Initiative. (June, 2010). Reaching higher: The common core state standards validation committee. In *A report from the National Governor's Association Center for Best Practices and the Council of Chief State School Officers.* Retrieved June, 2010, from http://www.corestandards.org/assets/CommonCoreReport_6.10.pdf.

Crompton, H. (2013). A historical overview of mobile learning: Toward learner-centered education. In Z. L. Berge & L. Y. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 3–14). Florence, KY: Routledge.

Cuendet, S., Bonnard, Q., Do-Lenh, S., & Dillenbourg, P. (2013). Designing augmented reality for the classroom. *Computers & Education, 68*, 557–569.

Dede, C. (Speaker) (2008). Immersive interfaces for learning: Opportunities and perils [motion picture]. Retrieved from http://cyber.law.harvard.edu/interactive/events/luncheon/2008/12/dede.

Di Serio, A., Ibanez, M., & Kloos, C. (2013). Impact of an augmented reality system on students' motivation for a visual art course. *Computers & Education, 68*, 586–596.

Gay, G. & Lentini, M. (1995). Use of communication resources in a networked collaborative design environment, Journal of Computer-Mediated Communication, 1(1). doi: 10.1111/j.1083-6101.1995.tb00320.x.

Greenhow, C. & Robelia, B. (2009). Web 2.0 and classroom research: What path should we take now? *Educational Researchers, 38*(4), 246–259.

Gremmo, M. J., & Riley, P. (1995). Autonomy, self -direction and self-access in language teaching and learning: The history of an idea. *System, 23*(2), 151–164.

Hamilton, K. & Olenewa, J. (May, 2010). Augmented reality in education [PowerPoint slides]. Retrieved May, 2010, from http://www.authorstream.com/Presentation/k3hamilton-478B23-augmented-reality-in-education/.

Inkpen, K. (1997). *Adapting the human computer interface to support collaborative learning environments for children*. Ph.D. Dissertation, Department of Computer Science, University of British Columbia.

Johnson, L., Adams-Becker, S., Estrada, V., & Freeman, A. (2015). *NMC Horizon Report: 2015 K-12 Edition*. Austin, Texas: The New Media Consortium.

Jonassen, D., Howland, J., Marra, R., & Crismond, D. (2008). *Meaningful learning with technology* (3rd ed.). Upper Saddle River, NJ: Pearson.

Kerawalla, L., Luckin, R., Seljeflot, S., & Woolard, A. (2006). "Making it real": Exploring the potential of augmented reality for teaching primary school science. *Virtual Reality, 10*, 163–174.

Kesim, M., & Ozarslan, Y. (2012). Augmented reality in education: Current technologies an the potenial for education. *Procedia—Social and Behavioral Sciences, 47*, 297–302.

Kirkley, S., & Kirkley, J. (2005). Creating next generation blended learning environments using mixed reality, video games and simulations. *TechTrends, 49*(3), 42–54.

Klopfer, E. (2008). *Augmented learning: Research and design of mobile educational games*. Cambridge, MA: MIT Press.

Klopfer, E., & Squire, K. (2008). Environmental Detectives—the development of an augmented reality platform for environmental simulations. *Educational Technology Research and Development, 56*(2), 203–228.

Klopfer, E., & Yoon, S. (2004). Developing games and simulations for today and tomorrow's tech savvy youth. *TechTrends, 49*(3), 33–41.

Lee, K. (2012). Augmented reality in education and training. *Techtrends, 56*(2), 13–21. doi:10.1007/s11528-012-0559-3.

Milgram, P. & Kishino, F. A. (1994). Taxonomy of Mixed Reality Visual Displays. Institute of Electronics, Information, and Communication Engineers Trans. *Information and Systems (IECE special issue on networked reality), E77-D* (12), 1321–1329.

Óhidi, A. (2006). Az élethosszig tartó tanulás és az iskola, Új Pedagógiai Szemle.

Pasaréti, O., Hajdú, H., Matuszka, T., Jámbori, A., Molnár, I., & Turcsányi-Szabó, M. (2011). Augmented reality in education. *INFODIDACT Informatika Szakmódszertani Konferencia.*

Sharples, M. (2005). Learning as conversation: Transforming education in the mobile age. In *Proceedings of Conference on Seeing, Understanding, Learning in the Mobile Age*, Budapest, Hungary (pp. 147–152).

Steinkuehler, C., & Williams, D. (2006). Where everybody knows your (screen) name: Online games as "third places". *Journal of Computer-Mediated Communication, 11*(4), 885–909.

Wasko, C. (2013). What teachers need to know about augmented reality enhanced learning environments. *Techtrends, 57*(4), 17–21. doi:10.1007/s11528-013-0672-y.

Wu, H., Less, S., Chang, H., & Liang, J. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*, 41–49.

Yuen, S., Yaoyuneyong, G., & Johnson, L. (2011). Augmented reality: An overview and five directions for AR in education. *Journal of Educational Technology Development and Exchange, 4*(1), 119–140.

Author Biographies

Susan Herrington Kidd is an Elementary Education graduate student at Old Dominion University, Virginia. She gained her Bachelor of Arts in Anthropology from Arizona State University. Kidd's study and research interests include the utilization of technology to assist students on the autism spectrum and the effective utilization of technology throughout K-12 education. Kidd exploits the affordances of technologies as she works as a substitute teacher for Chesapeake Public Schools Virginia. This teaching experience has provided Kidd with opportunities to work with diverse groups of students to better understand how technology can be used to support all learners.

Helen Crompton (Ph.D.) is an Assistant Professor of Instructional Technology at Old Dominion University, Virginia. Professor Crompton is a keen researcher and educator in the field of instructional technology. She gained her Ph.D. in educational technology and mathematics education from the University of North Carolina at Chapel Hill. Her research is focused on mobile learning and the effective integration of technology into K-12 education. Dr. Crompton works as a consultant for two United Nations Agencies (United Nations, Educational, Scientific, and Cultural Organization: UNESCO and International Telecommunication Union: ITU) to research, author and edit publications summarizing research on mobile learning. Dr. Crompton is also a faculty member for the International Society for Technology in Education (ISTE), teaching the ISTE Standards academy, consulting, and recently designing ISTE's self –paced Mobile Learning Academy and Verizon's Mobile Learning Academy.