

# Inter-Identity Technologies for Learning

Robb Lindgren, University of Central Florida,  
12461 Research Parkway Suite 500, Orlando, FL 32826-3241, USA, robb.lindgren@ucf.edu  
Roy Pea, Stanford University,  
485 Lasuen Mall, Stanford, CA 94305-3096, USA, roypea@stanford.edu

**Abstract:** We propose a new framework for conceptualizing media technologies that blur the distinction between the self and the other. We refer to these as “inter-identity technologies” (IITs) and we describe both theoretical and empirical support for these technologies as having special properties for generating learning. Several examples of IITs are offered such as video games where a first-person perspective is augmented with data visualizations, or digital characters to which a learner’s attributes can be imparted and their activity subsequently observed. We review several studies that have been conducted on digital environments we classify as IITs and discuss their impact on various types of learning. In an effort to forge a coherent research agenda, we propose three lines of inquiry pertaining to inter-identity and the design of digital media.

## Introduction

In keeping with the ICLS 2012 theme of “The Future of Learning”, we introduce a new and generative framework for conceptualizing developments in new media technologies for learning and education. While we lay out our argument below for why we have chosen to articulate these opportunities in terms of the phrase “inter-identity technologies for learning”, we foreshadow our reasoning with two key points. The first point is the deepening recognition of the profoundly social nature of learning, and the integral relationship of learning to the development of personal identity (Gee, 2000; Hull & Greeno, 2006; Lave & Wenger, 1991), because self-conceptions of who one is, who one may become, and who and with what domains and tasks one affiliates may open up or close down learning opportunities (Nasir, 2011; Wortham, 2006). The second is that information and communication technologies do not simply serve as ‘amplifiers’ of cognition and social relations, but re-structure them in new functional and activity systems (Cole & Griffin, 1980; Engestrom, 1999; Pea, 1985, 2004). If we take seriously the social construction of identity as integral to learning, and the integral nature of technologies in the functional systems of intelligence in which people act, we should work to deeply mine the new opportunities for advancing the future of socially-mediated learning. We begin that quest in this paper by turning our attention to the pedagogical prospects wrought by bringing together the affordances of new media technologies and the inter-relating of the identities of the learner and others, real and virtual.

## Inter-Identity: New Possibilities of an Increasingly Digital Life

Sherry Turkle has highlighted how “we come to see ourselves differently as we catch sight of our images in the mirror of the machine” (Turkle, 1999, p. 643; Turkle, 1995). Her work has highlighted how individuals negotiate what she calls the virtual and the “real” when people represent themselves on the computer screens available to others through the Internet. Through such identity presentations, people can experience how others respond to them in the identity or identities that they are formulating and expressing. Her ethnographic studies of the performative nature of identity work online lead Turkle to place a primary emphasis on the multiplicity and flexibility of a person's identity, more fluid and multi-faceted than many identity theorists from the social sciences have previously advocated. Over the past several decades, a voluminous literature has been developed on how interacting by means of textual and avatar representations of the self in virtual worlds or in multi-player games provides fertile occasions for identity play, and for the social construction of identity, that are uniquely contributed by means of technology mediation rather than in face to face interaction (Calvert, 2002; Huffaker & Calvert, 2006; Ito, Baumer, Bittanti, Boyd, Cody, Herr-Stphenson, et al., 2009; Kendall, 1998; Thomas, 2007; Turkle, 1995; Turkle, 1999; Valkenburg, Schouten, & Jochen, 2005). Among the many aspects of identity experimentation that have been emphasized in these works on identity online are gender, race, class, ethnicity, culture, age, religion, profession, power, and orientation.

While such sociological, psychological, anthropological, and cultural studies are important and defining in significant ways for our era, our concerns are more focused on the powerful potentials of the representational and interactive affordances of information and communication technologies for developing *new frameworks* for pedagogy and for learning - not only about the self and others in social relations, but about the multiplicity of aspects of expertise, in terms of conceptual, spatial and procedural knowledge, involved in performing complex actions in the communities of practice represented in the activities of school, work, play, and society more broadly. Before we define the new framework opportunities, consider the face-to-face communicative infrastructure for identity development in a pre-technological era. Either observed or reported

human action and associated characteristics of personal identity served as the available cultural resource for identity development. Children had occasions to observe different models in their accessible social groups and to emulate aspects of the behaviors, beliefs, orientations of those individuals. Enactments of aspects of one's developing personal identity could then be subject to social feedback and regulation, with extreme behaviors subject to stigma, isolation or exclusion from social groups. The powerful human technology of narrative storytelling opened up the possibilities of identity models from by-gone eras, even before texts made their permanent inscription in a fixed form possible. In a pre-technological era, identity expressions among adults and identity enactments among youth and feedback from others were transient in experience, unrepresented in an inspectable medium.

Today, beyond the stories and myths wrought in tale and text, video, film and computer games all serve as representational media of possible identities and subject of attention for youth and adults who are always in process of developing and elaborating their personal identities. These technologies have become more powerful and intimate as they have become interactive technologies among people, not only for watching, as in television and film. What special opportunities does this representational ecology offer for advancing the learning of complex competencies?

While we cannot in this short paper provide an account of landmarks in the history of film, television, and computing that brought about innovations in the experiential possibilities of media as resources for identity development, salient examples from popular media of the power of the technical affordances of video and computer representations include:

(1) *Point-of-view films*, such as the *Blair Witch Project*, in which first-person camera techniques are used to create the sensation for moviegoers that they are present in the scene that is captured on film, with greater reality-quotient to the events, dangers, risks, uncertainties that are present in the narrative line of the movie. This genre of film-making is often described as 'found footage', and is most typically used for horror movies.

(2) *First-person gaming perspective*. Video games where the user can select a "first person" rather than a "third person" perspective to experience the gameplay in a more immersive manner. First-person shooters are perhaps best known for uses of this graphical perspective, but flight simulators and adventure games are well-known exemplars as well.

(3) *Virtual worlds co-populated with graphical avatars representing humans and agents representing computer programs*. In a variety of multi-user virtual environments—from the text-based MUD (multi-user dungeon), *LambdaMoo* to today's *Second Life* and other virtual worlds—and massively multiplayer role playing games, human players encounter not only other players but embodied agents in the game that are running computer programs that generate their behaviors and communications to the user community. In developing expertise in game play, interactions with both avatars and agents contribute to learning, but the usual framing of agents as contributors to players' learning is by analogy to the role of a face-to-face human teacher or a guide who offers advice or impacts knowledge, wisdom, or clues.

New media technologies like immersive online games, interactive video and virtual worlds enable players and game designers to shift the point of view from which people play or watch, blurring the participant's perspective with that of another. We refer to technologies that blur the boundaries between self and other as "inter-identity technologies" (IITs). We argue in this paper that the learning-relevant properties of these new media infrastructures for IITs have been underutilized for fostering learning and expertise development. We see enormous opportunity in the design, development, and study of IITs for learning and teaching. Inter-identity refers to the co-mingling of a learner's identity with a virtual character/avatar that can produce psychological phenomena such as heightened arousal, attention to key features, engagement, memory, learning, performance and a sense of responsibility. The inter-identity technological system might, for example: (1) enable the learner to see through the avatar's point of view things that the learner on his or her own might not notice, leading to more expert-like attention and behavior, or (2) enable the learner to teach a computer agent to do things which the learner then takes responsibility for in the performance of the agent, or (3) occasionally take over control of the learner's avatar in a virtual environment so that it acts more expertly – an intervention we allude to as "scaffolding on steroids."

## **The Power of Blending: Theoretical Support for Using Inter-Identity Technologies for Learning**

Emerging media technologies make it possible to create immersive experiences where the resulting activity is a blending of the knowledge and behavior of multiple individuals. The notion that this blending can be leveraged for powerful effect in learning environments has support from theoretical work in educational psychology, neuroscience, and human-computer interaction.

## **The Social Foundations of Learning**

IITs present a unique mode of social interaction in that there is typically an absence of face-to-face or direct conversational exchange with others. There is, however, an implicit awareness of others' presence and the influence they bring on the activity at hand. We argue that this awareness provokes the mechanisms of learning that stem from our makeup as social creatures—working together to solve problems and using each other as models and guides towards our own inquiry and understanding. Recent research on learning has shown the extent to which our social nature pervades our thinking and learning processes. From an early age children use subtle cues from parents and others that shape not only the content of their learning but the focus of their learning pursuits (Meltzoff, Kuhl, Movellan, & Sejnowski, 2010). Studies have demonstrated the critical importance of these cues originating from human actors (or at least the belief as such) compared to inanimate or robotic sources (Meltzoff, 2007; Okita, Bailenson, & Schwartz, 2007). Unlike other forms of computer-mediated interaction, IITs actively evoke social cues, albeit in sometimes covert and subtle ways that integrate themselves with the individual's own perceptual system.

In addition to providing a raw social stimulus to activate basic mechanisms of learning, IITs can also effectively situate an individual within the authentic and complex social contexts where learning typically occurs. Theories of situated and distributed learning maintain that the activity structures that emerge from authentic social practices and the tools available within these environments should themselves be viewed as cognitive processes that support learning (Brown, Collins, & Duguid, 1988; Lave & Wenger, 1991; Pea, 1993; Scardamalia & Bereiter, 1994). Fueled by this perspective many of the new designs and reforms in education involve making traditionally independent learning activities more social and collaborative, and frequently this has produced positive results. For example, a meta-analysis of computer-based activities in schools showed that students tended to learn more when these activities were performed in groups (Lou, Abrami, & d'Apollonia, 2001). Of course, the quality of the interaction in a collaborative activity has much to say about what is ultimately learned (Barron, 2003). With IITs it is possible for the characteristics of a productive social interaction to be designed into experience (e.g., constraints that ensure that the correct ideas and interpretations remain the focus). A good example of digital media technologies situating an individual within a complex social environment are video games. Gee (2003) describes the unique ability of these games—whether their focus is combat, adventure, solving puzzles, etc.—to embed someone within an authentic environment and equip them with the tools and knowledge to perform optimally. These games make it possible for players to assume (partially) the identity of a competent other, creating the conditions for new learning.

## **Overlapping Neurological Systems for Self and Other**

The effectiveness of technology designs that blend the experiences of one person with those of another relies on our ability to effectively integrate our own perceptions with information we receive from other sources. Recent research in perceptual psychology suggests that people instinctively incorporate visual perspectives of others when making visual judgments, and that we are capable of doing so quite rapidly (Samson, Apperly, Braithwaite, Andrews, & Bodley Scott, 2010). Amongst neuroscientists it has been proposed that humans (and animals) have a system of “mirror neurons” in the motor cortex that are activated both when performing an action and observing those actions as performed by others (Rizzolatti & Craighero, 2004). The implication is that there are strong perception-action connections built into our brains that can facilitate their integration into a coherent experience (e.g., I see actions being performed as my own even if they are partially controlled by others). A particularly relevant study in neuroscience showed that while there was activation in the motor cortex by participants when observing an actor's video recorded movement (hand and foot motion), this activation was greatest when viewing these actions from the actor's viewpoint (i.e., as if the actions were their own) (Jackson, Meltzoff, & Decety, 2006). Findings such as these suggest that people are capable of naturally assimilating sensory experience transmitted via digital media.

## **Opportunities for Perspective-Taking**

There has been a great deal of research in psychology demonstrating broad cognitive benefits for perspective-taking interventions on learning (e.g., Anderson, Pichert, & Shirey, 1983; Siegler, 1995), and in education the positive effects of giving students new perspectives on content have been shown in history (Davis, Yeager & Foster, 2001), science (Linn, Bell, & Hsi, 1998), and mathematics (Resnick & Wilensky, 1998). In most cases perspective-taking interventions involve the mental simulation of another person's point of view, but with IITs it is possible to give a person novel perspectives in a much more literal way, by co-opting their perceptual system and allowing them to experience aspects of the world the way someone else experiences them. Perspective-taking with digital media can conceivably be accomplished in numerous ways, but studies using a diverse set of approaches and technologies have shown learning benefits akin to those shown for non-computer-mediated perspective-taking. For example, Grant and Spivey (2003) improved participant performance using eye tracking technology to digitally highlight features of a problem solving task that had proven to be critical to the success of previous participants. Likewise, it was shown that being given multiple perspectives in a virtual

environment (both egocentric and exocentric) improved learning related to a design task (Salzman, Dede, & Loftin, 1999). We are particularly excited about the possibility of using IITs to convey “expert perspectives”—simulations of how experts in some domain interact with artifacts and representations (e.g., what features do they look at to make critical decisions). The hope is to create a process analogous to the way experts have been shown to convey field knowledge to novices in domains such as archeology (e.g., highlighting important perceptual contrasts: Goodwin, 1994).

## Demonstrations of Inter-Identity Technologies Impacting Learning

As discussed above, several digital media designs exist that could be considered IITs—everything from first-person films to certain kinds of video games—but there have been relatively few studies focused on the features of these technologies that facilitate identity blending and the impact that they have on learning. We review a few examples here that we consider to be good examples of designs that attempt technology-mediated identity development targeted at enhancing learning, but by no means do we consider this list exhaustive, and we invite others to offer up their ideas and designs for what constitutes inter-identity.

### First-Person Expert Perspectives in Digital Video

Giving viewers of video a first-person perspective (e.g., handheld camera recording) of events has been used for good effect in generating engagement and a feelings of gritty realism in films, but can these same conditions of video be used to promote learning? And if so, does it matter who is holding the camera? These were the questions asked in a set of studies that examined people’s ability to learn from an instructional video about how a toaster works. An initial study compared learning when the video was shot from the first-person perspective of the “expert” (head-mounted camera) compared to a third-person (tripod-mounted camera) recording of the same event (Figure 1). Results showed that participants in the first-person condition actually learned more based on their responses to a set of inference questions administered after watching the video (Lindgren, Pea, & Lewis, 2008). A follow-up study attempted to isolate the features of the video that produced the learning effect (e.g., motion, perspective), and results indicated that learning and engagement was highest when the motion in the video was consistent with the actions and utterances of the expert (Lewis, Lindgren, & Pea, under review). The suggestion is that learning from digital video can be enhanced when viewers are given the opportunity to view events as they are seen by an expert, and perhaps even feeling what it is like to be an expert in that domain. These studies highlight that a media technology as accessible and as ubiquitous as digital video can be leveraged as an IIT when the appropriate design considerations are applied.



**Figure 1.** Instructional video shot as an IIT showing events from the expert’s perspective (left) and the same event shot from the perspective of a passive observer (no camera movement) (right).

### Imparting Knowledge to Computer Agents

A second paradigm of IIT involves the transfer of personal characteristics to a computer agent and then monitoring the behavior of that agent as an outside observer. This could involve, for example, creating a character in a video game that looks like you and watching to see how people respond to that character. More pertinent to the topic of IIT’s for learning, however, is the notion of a computer character to whom one can impart their knowledge or their reasoning about some topic and then observe how that character fares when confronted with challenges in that domain. It is a process that can be seen as analogous to teaching a student and then watching that student perform on a test or execute some other demonstration of what they’ve learned, and it is the basis of the Teachable Agents paradigm of computer software being built at Vanderbilt and Stanford University (Biswas, Schwartz, Leelawong, Vye, & TAG-V, 2005). Recent research on Teachable Agents in the classroom have shown that the process of instructing computer agents can have lasting benefits for future learning experiences without the agents (Chin, Dohmen, Cheng, Oppizzo, Chase, & Schwartz, 2010) and that

students will actually work harder to learn for their agents than they will to learn for themselves (Chase, Chin, Oppezzo, & Schwartz, 2009). Unlike other IITs where the technology allows the user to bring characteristics of others' identities into their own, Teachable Agents provide an opportunity to transfer part of one's identity (i.e., their understanding of a domain) to an external entity that can be observed and evaluated.

### Expert Perspectives in Virtual Environments

Just as the perspective of a knowledgeable other can be built into digital video, so too can expert perspectives be built into the interactions users have with screen-based virtual environments such as video games and social virtual worlds. Lindgren (in press) showed that participants who experienced an expert's actions from the first-person perspective in a virtual world training simulation performed better and learned more than participants who viewed the same actions from a fixed virtual camera in the simulation space. When allowed to perform the simulated actions independently, participants who were trained through the eyes of an expert committed fewer errors and exhibited less help-seeking behavior. Outside of the simulation participants with the expert view could recall more of the important simulation elements and drew more accurate diagrams of the virtual environment. These IIT effects within virtual environments can likely be integrated directly into the simulation activity itself. For example, Lindgren (2009) describes a version of the training simulation that is fully under the control of the user until they made a critical error, at which point the simulation takes over (Figure 2) and shows the user what it would be like to perform the action correctly, followed by an opportunity to perform the correct actions on their own. This is the type of intervention we refer to as "scaffolding on steroids." Similar approaches for mixing in expert identities in real time have already been utilized in commercial video games. The game *Batman Arkham Asylum*, for example, has a "detective mode" where important objects and areas of interest are highlighted to encourage more productive inquiries into the virtual environment.



**Figure 2.** The eye icon in the upper left indicates that the simulation has temporarily taken control away from the user to highlight the correct actions in the first-person perspective.

### Altered Identity and Behavior in Virtual Reality

As a final example of IIT we describe the capacity of fully immersive virtual environments such as goggle-based VR to convey realistic but altered depictions of experience in real time. Jeremy Bailenson has created and studied numerous of these experiences in a paradigm referred to as Transformed Social Interactions (TSIs) (Bailenson, Beall, Loomis, Blascovich, & Turk, 2004). TSIs involve altering the way that actions in a virtual environment are rendered, such as augmenting non-verbal behavior or "gaze enhancement" where a single actor can have direct eye contact with multiple people at the same time (i.e., all participants in the environment receive a rendering of the environment where the speaker is looking at them). Bailenson and colleagues have demonstrated that TSIs enacted in simulated learning environments such as classrooms can have positive consequences on learning and attention (Bailenson, Yee, Blascovich, Beall, Lundblad, & Jin, 2009). In this case, inter-identity is achieved by merging an individual's real time behavior with the strategic alterations of a system designed to optimize the outcome of that behavior. Modifying the way that we see others or ourselves in the course of activity can change what and how we learn.

### Solidifying an IIT Research Agenda

Given strong theoretical backing and the few provocative exemplars described above, we believe that inter-identity technologies presents itself as a fascinating and important research strand for developing the future of learning. In order to move beyond a few interesting studies, however, it will be necessary for future research to address head-on some important questions elicited by the notion of inter-identity. We outline what we see as the three central questions here.

(1) *In what ways can identity be convincingly and practically blended?* The examples above suggest a few ways in which the identities of learners, experts, designers, etc. can be comingled into a coherent interactive experience, but there are certainly other ways that this can be achieved and should be explored. One possible dimension that could be used to define these methods of integration is whether the characteristics of new identities are brought within, such as watching video recorded from a head camera, or whether they are imparted upon external entities, as is done with Teachable Agents. Perhaps more importantly, this line of research will require new instruments sensitive to whether learners' feel that a transaction involving identity has occurred. Similar to instruments that have been developed to detect abstract constructs such as *presence* (e.g., Witmer & Singer, 1999), we believe that it would be useful to develop tools for gauging the degree of experienced inter-identity.

(2) *What are characteristics of existing and future technologies required to support inter-identity interventions?* The demonstrated utility of IITs described in this paper suggests that identity blending is a focus that should be taken up not just by psychologists and philosophers, but by computer scientists and developers. Creating an authentic and fluid experience that shares attributes of the self and other—potentially in real time—is a non trivial task that can require expertise in graphics, AI, haptics, computer vision, and HCI. In fact, we believe that IITs constitute a new frontier in user experience design that could drive technology innovation. It is our hope that these advances are accompanied by rigorous study to determine the mechanisms by which inter-identity is achieved.

(3) *What are the specific learning affordances of the different types of identity blending?* We readily acknowledge that all types of IITs are likely not optimal for all types of learning. For example, it is hard to imagine (though not impossible) how first-person digital video could be used to teach organic chemistry. Thus in order to aid in the design of IITs it is imperative that we begin to map their characteristics to the ability to support specific types of learning. Ideally the bulk of IIT research would reside here as these studies would further both our understanding of inter-identity effects on cognition as well as to develop practical guidelines for developing effective educational platforms.

## Conclusion

We have introduced a new framework for understanding and designing learning technologies that we hope will be instrumental to shaping the future of learning. Inter-identity technologies are a spectrum of digital media designs that in some way blend the experience, knowledge, and beliefs of multiple individuals. We have presented both theoretical and empirical support for the efficacy of IITs for generating learning, and we have suggested new lines of inquiry to fuel a promising research agenda. Identity is a highly complex and abstract construct, but emerging media technologies are making it possible to explore identity in concrete and productive ways. The idea that simple manipulations using IITs could lead one to be more expert-like in their learning pursuits or to view themselves as being more capable of tackling difficult challenges is exciting, and we believe it is an area of research worthy of active investigation.

## References

- Anderson, R. C., Pichert, J. W., & Shirey, L. L. (1983). Effects of the reader's schema at different points in time. *Journal of Educational Psychology*, 75(2), 271-279.
- Bailenson, J., Beall, A., Loomis, J., Blascovich, J., & Turk, M. (2004). Transformed social interaction: Decoupling representation from behavior and form in collaborative virtual environments. *Presence*, 13(4), 428-441.
- Bailenson, J. N., Yee, N., Blascovich, J., Beall, A. C., Lundblad, N., & Jin, M. (2009). The use of immersive virtual reality in the learning sciences: Digital transformations of teachers, students, and social context. *The Journal of the Learning Sciences*, 17, 102-141.
- Barron, B. J. (2003). When smart groups fail. *Journal of the Learning Sciences*, 12, 307-359.
- Biswas, Schwartz, Leelawong, Vye, & TAG-V (2005). Learning by teaching: A new agent paradigm for educational software. *Applied Artificial Intelligence*, 19, 363-392.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Education Researcher*, 18(1), 32-42.
- Calvert, S. L. (2002). Identity construction on the internet. In S. L. Calvert, A. B. Jordan & R. R. Cocking (Eds.), *Children in the Digital Age: Influences of Electronic Media on Development* (pp. 57-70). Westport, CT: Praeger.
- Chase, C. C., Chin, D. B., Oppezzo, M. A., & Schwartz, D. L. (2009). Teachable agents and the protégé effect: Increasing the effort towards learning. *Journal of Science Education and Technology*, 18(4), 334-352.

- Chin, D. B., Dohmen, I. D., Cheng, B. H., Oppezzo, M. A., Chase, C. C., Schwartz, D. L., (2010). Preparing students for future learning with teachable agents. *Education Tech Research Dev.*, 58, 649–669.
- Cole, M., & Griffin, P. (1980). Cultural amplifiers reconsidered. In D. R. Olson (Ed.), *The social foundations of language and thought: Essays in honor of Jerome S. Bruner* (pp. 343-364). New York: Norton.
- Davis, O. L., Yeager, E. A., & Foster, S. J. (2001). *Historical empathy and perspective taking in the social studies*. Lanham, MD: Rowman & Littlefield.
- Engestrom, Y. (1999). Activity theory and individual and social transformation. In Y. Engestrom, R. Miettinen & R-L Punamaki (Eds.), *Perspectives on activity theory* (pp. 19-38). New York: Cambridge University Press.
- Gee, J. P. (2000). Identity as an analytic lens for research in education. *Review of Research in Education*, 25, 99-125.
- Gee, J. P. (2003). *What video games have to teach us about learning*. New York: Palgrave.
- Goodwin, C. (1994). Professional vision. *American Anthropologist*. 96(3), 606–633.
- Grant, E. R., & Spivey, M. J. (2003). Eye movements and problem solving. Guiding attention guides thought. *Psychological Science*, 14, 462–466.
- Huffaker, D. A., & Calvert, S. L. (2006). Gender, identity, and language use in teenage blogs. *Journal of Computer-Mediated Communication*, 10(2).
- Hull, G., & Greeno, J. (2006). Identity and agency in non-school and school worlds. In Z. Bekerman, N. C. Burbules & D. Silberman-Keller (Eds.), *Learning in places: The informal educational reader* (pp. 77-97). New York: Peter Lang.
- Ito, M., Baumer, S., Bittanti, M., Boyd, D., Cody, R., Herr-Stephenson, B., et al. (2009). *Hanging out, messing around, and geeking out: Kids living and learning with new media*. Cambridge, MA: MIT Press.
- Jackson, P.L., Meltzoff, A.N., Decety, J. (2006). Neural circuits involved in imitation and perspective-taking. *NeuroImage*, 31(1), 429-439.
- Kendall, L. (1998). Meaning and identity in “cyberspace”: The performance of gender, class, and race online. *Symbolic Interaction*, 21(2), 129-153.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Lewis, S., Lindgren, R., & Pea, R. (under review). Learning with media: Harnessing viewpoint and motion to generate fields of potential action.
- Lindgren, R. (2009). Learning in a virtual world simulation environment: A perspective-taking approach. Paper presented at the annual meeting of the *American Education Research Association*, San Diego, CA.
- Lindgren, R. (in press). Generating a learning stance through perspective-taking in a virtual environment. *Computers in Human Behavior*.
- Lindgren, R., Pea, R., & Lewis, S. (2008). The impact of perspective in digital video on conceptual learning outcomes. Paper presented at the annual meeting of the *American Education Research Association*, New York, NY.
- Linn, M., Bell, P., & Hsi, S. (1998). Using the Internet to enhance student understanding of science: The Knowledge Integration Environment. *Interactive Learning Environments*, 6, 4–38.
- Lou, Y., Abrami, P. C., & d'Apollonia, S. (2001). Small group and individual learning with technology: A meta-analysis. *Review of Educational Research*, 71(3), 449-521.
- Meltzoff, A. N. (2007). 'Like me': A foundation for social cognition. *Developmental Science*, 10, 126-134.
- Meltzoff, A. N., Kuhl, P. K., Movellan, J., & Sejnowski, T. J. (2009). Foundations for a new science of learning. *Science*, 325(5938), 284–288.
- Nasir, N. S. (2011). *Racialized identities: Race and achievement among African American youth*. Stanford, CA: Stanford University Press.
- Okita, S. Y., Bailenson, J., & Schwartz, D. L. (2007). The mere belief of social interaction improves learning. *Proceedings of the Twenty-ninth Meeting of the Cognitive Science Society*. Nashville, TN.
- Pea, R. D. (1985). Beyond amplification: Using computers to reorganize human mental functioning. *Educational Psychologist*, 20, 167-182.
- Pea, R. D. (1993). Practices of distributed intelligence and designs for education. In G. Salomon (Ed.), *Distributed cognitions* (pp. 47-87). Cambridge, UK: Cambridge University Press.
- Pea, R. D. (2004). The social and technological dimensions of “scaffolding” and related theoretical concepts for learning, education and human activity. *The Journal of the Learning Sciences*, 13(3), 423-451.
- Resnick, M., & Wilensky, U. (1997). Diving into complexity: Developing probabilistic decentralized thinking through role-playing activities. *Journal of the Learning Sciences* 7(2), 153–172.
- Rizzolatti, G., & Craighero, L. (2004). The mirror neuron system. *Annual Review of Neuroscience*, 27, 169-192.
- Salzman, M. C., Dede, C., & Loftin, R. B. (1999). VR's frames of reference: A visualization technique for mastering abstract information spaces. In *Proceedings of CHI '99* (pp. 489–495). Pittsburgh, PA: ACM Press.

- Samson, D., Apperly, I. A., Braithwaite, J. J., Andrews, B. J., Bodley Scott, S. E. (2010). Seeing it their way: Evidence for rapid and involuntary computation of what other people see. *Journal of Experimental Psychology: Human Perception and Performance*, 36(5), 1255-1266.
- Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences*, 3(3), 265-283.
- Siegler, R. S. (1995). How does change occur: A microgenetic study of number conservation. *Cognitive Psychology*, 28, 225-273.
- Thomas, A. (2007). *Youth online: Identity and literacy in the digital age*. London: Peter Lang.
- Turkle, S. (1995). *Life on the Screen: Identity in the age of the Internet*. New York : Simon and Schuster.
- Turkle, S. (1999). Cyberspace and identity. *Contemporary Sociology*, 28(6), 643-648.
- Valkenburg, P. M., Schouten, A. P. & Jochen, P. (2005). Adolescents' identity experimentation on the internet. *New Media and Society*, 7(3), 383-402.
- Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments*, 7, 225-240.
- Wortham, S. E. F. (2006). *Learning identity: The joint emergence of social identification and academic learning*. New York: Cambridge University Press.