Teachers as Learning Designers
through Teachers' Design Thinking

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Abstract: Although greater attention has been paid to participatory learning environments in science education, researchers seldom point out that teachers benefit from interacting with students just as students benefit from interacting with teachers – which is one of central educational implications of Vygotskian theory. Hence, I aim to enhance what I call *design thinking*, teachers' active engagement in designing learning activities to meet the needs of 21st century digital learners.

Introduction

Recent advances in learning and instruction emphasize collaborative learning experiences in knowledge construction by immersing learners in authentic contexts that are often inaccessible without digital technologies (Dillenbourg, 1999). This research approach reflects a new understanding of how and where people are actually learning (Kim, 2012; Thomas & Brown, 2007). Learning is conceptualized as participation in socio-cultural activities (Vygotsky, 1997, 1997a) that are increasingly located beyond formal learning environments. Because of the rapid emergence of digital technologies, knowledge is no longer viewed as content within a specific domain. Rather, education needs to focus more on supporting learners in engaging in authentic inquiry and communities of domain-related practices – that is 'a participatory learning environment' (Barab et. al., 2001). In this light, the impact of model-based instruction is increasingly recognized as critical to providing learners with authentic inquiry learning experiences and transforming the way learners understand scientific phenomena (Schwarz & White, 2005).

In a similar vein, our research team (Kim, Lee, & Kim, 2011; Kim, Lee, & Ye, 2012) has designed the Embodied Modeling-Mediated Activity learning environments in informal astronomy workshops in Singapore. This research shows that although greater attention has been paid to participatory learning environments in science education, designing immersive, engaging and embodied learning experiences for students is still difficult for science teachers (Kim & Lee, in press). Researchers seldom point out that teachers benefit from interacting with students just as students benefit from interacting with teachers – which is one of central educational implications of Vygotskian theory. Hence, I aim to enhance what I call **design thinking**, teachers' active engagement in designing learning activities to meet the needs of 21st century digital learners. To this end, this program of research will explore and enrich teachers' perceptions and experiences of design thinking by integrating a range of hands-on learning experiences (i.e., modeling designs) in a technology-rich context in order to help digital-age students engage in critical inquiry in both formal and informal learning contexts and develop their multiliteracy competencies, the ability to use a range of representation resources including images, sounds, and gestures to make meaning beyond reading and writing print-based texts (Barton, 2007; Kim, 2011).

This research effort will be strongly grounded in how research-based design principles, derived from a deep understanding of effective learning designs, can be infused into formal and informal learning contexts. To achieve these research objectives, three research questions will be addressed: What are effective ways to promote elementary science pre-service teachers' design thinking that engages students in critical inquiry and develops multiliteracy competencies?; How can we co-design immersive, engaging and embodied learning experiences with elementary science pre-service teachers in and out of the classroom?; and What are the socio-technological infrastructures needed for sustaining and supporting pre-service teachers' design thinking?

Theoretical Framework

The theoretical framework for this study comes from three interrelated design features of a participatory learning environment, drawing on Vygotskian cultural-historical activity theory (Cole, 1988; Engeström, 1987; Vygotsky, 1997); and my previous research in designing immersive, engaging and embodied learning activities for promoting science learning: creative apprenticeship, empathic participation, and embodied experiences.

Methodology

Drawing on this theoretical framework, this program of research will require investigation into the actual practices of involving pre-service science teachers' design thinking toward developing immersive, engaging and embodied learning activities for digital-age learners. It is essential for the researchers to become engrossed in the research participants' situations through developing reflective practices (Eisner, 1991; Kim, 2014), which will be required to respond to emerging participants' interests, abilities and challenges and to co-design, enact and reflect on the multimodal modeling activities. In this light, the Design-Based Research (DBR) (Collins, Joseph, & Bielaczyc, 2004; Confrey, 2006) approaches will be effective for the researchers to become more

open, flexible and creative to identify critical elements of the design processes through implementation and modification responding to authentic contexts. By retrieving both the successes and failures from the implementation (Barab, 2006), the success of implication will contribute to the development of new theoretical insight to the theoretical framework. Hence, DBR will make a contribution to practice (enhancing teachers' design thinking of a multimodal modeling-integrated curriculum) and to theoretical understanding (developing a theory of teachers' design thinking across formal and informal settings) toward sustainable structures of teacher professional development.

Implications

Drawing on Vygotskian cultural-historical activity theory and my previous research in digital Learning Design with teachers and other school stakeholders, this program of research has implications for make theoretical advances in our understanding of Vygotskian and related theories such as embodied cognition integral to modeling-based teaching and learning, by identifying design principles that foster embodied cognition, the interplay between perceptional and motor behaviors and conscious cognitive processes. It will also promote pre-service teachers' design thinking toward designing modeling-based multiliteracy practices and creating a participatory learning environment to transform teacher education and professional development for digital-age students.

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