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Using Context-Aware Ubiquitous Learning to Support Students in Learning Angle Concepts

Mobile Learning

Mobile learning (mlearning) offers many new opportunities in the evolution of technology enhanced learning (Looi et al., 2010). These technologies are seeping into educational settings as the affordances are becoming recognized for the way in which they extend the pedagogical boundaries. Mlearning can provide a shift from the abstract concepts to the contextualized. In other words, students can better understand difficult subjects by connecting these concepts to the world in which they live, rather than relying on traditional textbook examples often used to teach students.

In the last decade, a subcategory of mobile learning has developed called context-aware ubiquitous learning (context-aware ulearning: Lonsdale, et al., 2004). Hwang et al. (2008) described context-aware ulearning as students learning in a real-world environment using a technology that interacts with the environment. This is how context-aware ubiquitous learning is being identified in this study. Students can use portable devices to learn by physically exploring and interacting with the real world (Colella, 2000; Squire & Klopfer, 2007).

Technologies to Support the Teaching and Learning of Geometry

School geometry is a complicated network of concepts, ways of thinking, and axiomatic representational systems that young students find difficult to grasp. Angle and angle measure in particular has many unique challenges. Prototype diagrams can lead students to considering non-relevant angle attributes (Yerushalmy & Chazan, 1993), such as the length of the rays and orientation (Battista, 2009; Clements, 2004). Using real-world connections in mathematics has many benefits to learning mathematics (see De Lange, 1996; National Research Council, 1998). Dynamic geometry environments (DGEs) have also been used to support students understanding of angle concepts. The review of the literature has revealed that real-world contexts and DGEs are two pedagogical approaches to supporting students learning of geometry.

Purpose of the Study

From a thorough review of the literature, it appears that very few researchers have taken advantage of using context-aware ulearning to support students learning in mathematics. In addition, no studies have been found to use DGEs with context-aware ulearning. The purpose of this study is to use real-world connections and a DGE to support 4th grade (9-10 years of age) students as they learn about angle concepts. Using Gravemeijer & van Eerde's (2009) design-based research methodology, a local instruction theory was developed that provided a set of exemplar curriculum activities and made additions to the theory of how context-aware ulearning can be used effectively in supporting students' understanding of angle and angle measure.

Methods

Participants

Two teachers and 60 fourth grade students from a school in the Southeastern United States participate in the study. Four students from each class were randomly selected to complete the pre-and post-instruction clinical interviews.

Design-Based Research Protocol for this Study

The study involved two macro cycles with one teaching experiment occurring in each macro cycle. The teaching experiments consisted of seven days of mini cycles of thought and instructional experiments to serve the development of the local instruction theory. For the context-aware ulearning components of this study, each student was given an iPad2 with the DGE Sketchpad Explorer and the add-on sketch titled *Measure a Picture* (Steketee & Crompton, 2012). In the playground and school building, students took photographs of angles and used the dynamic protractor and other tools to measure the angles in the pictures.

Scally's (1990) clinical interview was administered as the pre and post instruction test to four students from one class. Additional data were collected and these are illustrated in Figure 1. The second teaching experiment took place two weeks after the conclusion of the first teaching experiment. The local instruction theory came from the final retrospective analysis.

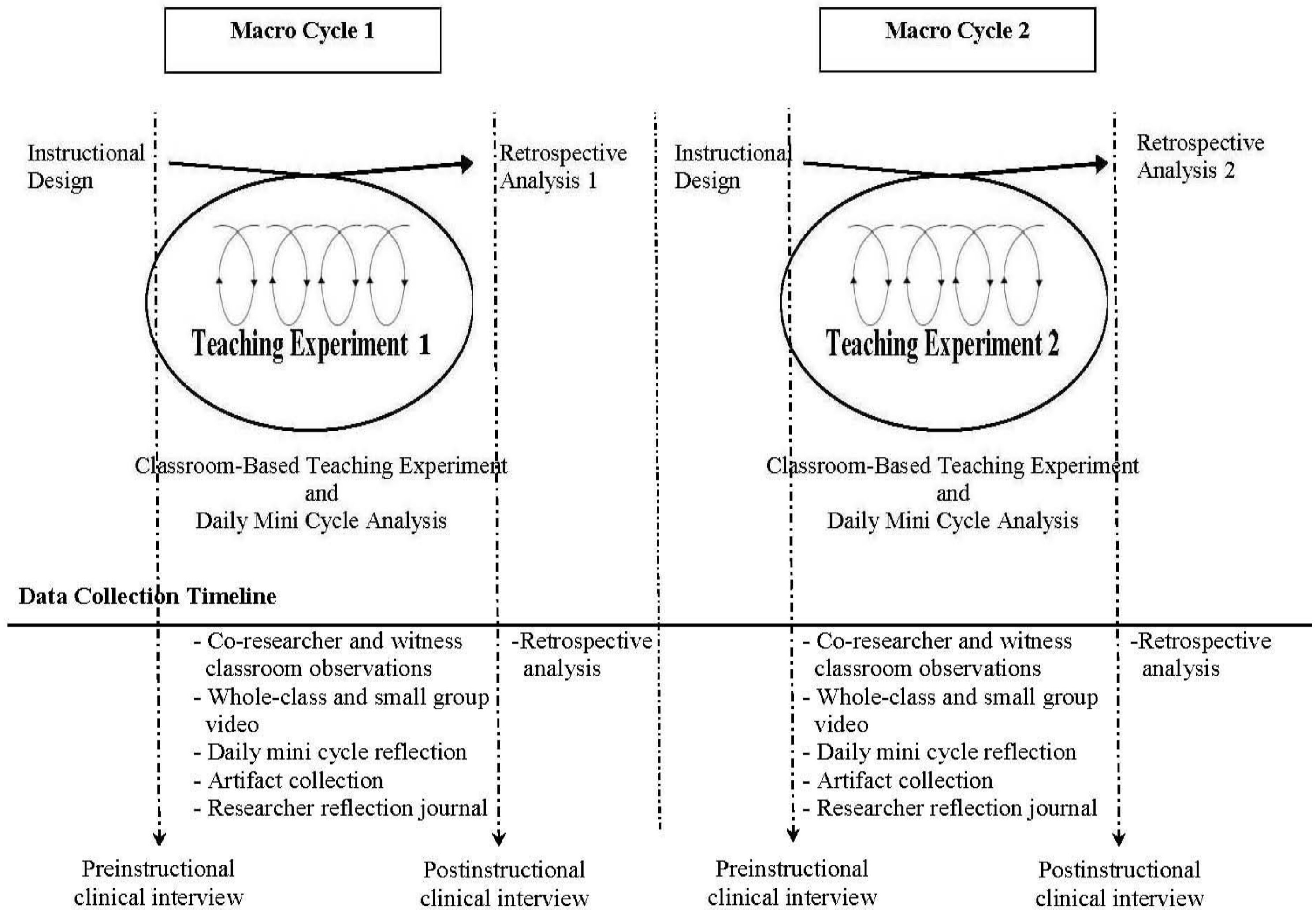

Figure 2.1. A Diagrammatic Representation of the Study with Points of Data Collection.

Results and Conclusion

This study resulted in an empirically-based local instruction theory of how context-aware ulearning can be used to support students' understanding of angle and angle measurement, and to support that process a set of exemplary instructional materials were devised to be an embodiment of that local instructional theory.

Extending the Theory

From this study, the researchers were able to uncover these design recommendations when developing activities that use context-aware ulearning to extend and enhance students' understanding of angle concepts: a) Include both context-aware ulearning activities with classroom based (traditional lessons) to use the contextualized learning outside the classroom to support decontextualized mathematics learning happening inside the classroom; b) ensure that students use a device with a large enough screen (e.g. a tablet) to enable students to adequately see the angles and have space to zoom in and share these images easily with a partner; c) Ensure that the rays of the angles on the application are extendable to ensure that the students do not consider length of the ray in connection with the size of the angle; d) Have students completing activities with others for students to make conjectures and be required to provide proof ; e) Have the students engaging in verbal mathematical discourse when working with peers to ensure they develop this skill rather than silently pointing to images on the screen; f) Initially choose a man-made environment to explore angles in the real world and later move to a natural environment. Angles are far less common in a natural environment, than in a man-made environment; and g) Students should remain in the same context as they work through the process of making conjectures and providing proof. This enables the student to look back at the real-world 3D angle to see if their arguments are reasonable.

Instructional Materials

Due to space constraints, the full set of activities developed from this study cannot be provided within this paper. The full plans can be found in this Dropbox file:

https://www.dropbox.com/s/buiy5lgve7qh4m2/DBR%20Lessons.pdf These activities positively improved students understanding of angle and angle measurement. All students appeared to show considerable growth on the interviews and many misconceptions were removed entirely. For example, using the app (Measure a Picture), the student in Figure 3.1 demonstrated that he/she no longer considered orientation a salient angle attribute and the length of the angle rays did not constitute the measure of the angles.

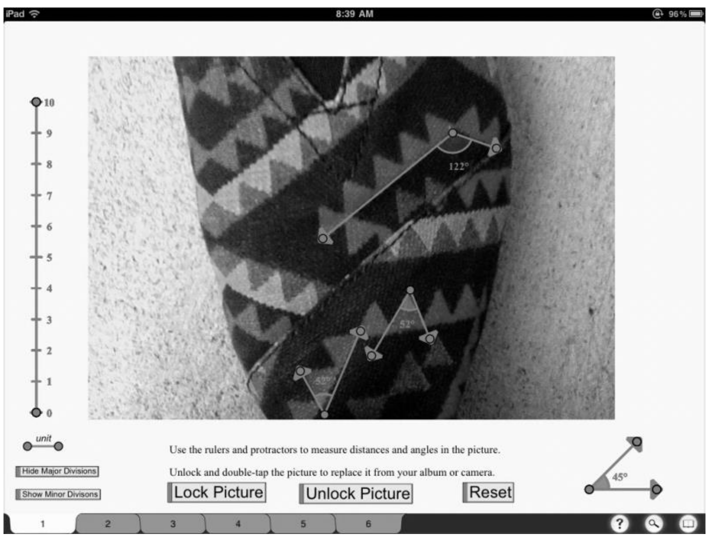

Figure 3.1. A student uses the app to demonstrate understanding of salient angle attributes.

From the study, evidence from the multiple data sources was triangulated and context aware ulearning was supportive in these ways: (a) from using the mobile devices to take photographs of the angles, the students were able first to see the 3D angles, which helped the students connect with the real-world angles; (b) as students became familiar with looking for angles in the real world, they realized that angle orientation did not matter; (c) the students could look back from the devices to see the physical angles which helped them determine if the final measure was plausible; (d) students were able to understand that an angle is the rotation from a point as the dynamic protractor demonstrated this movement; (e) students were supported in understanding that the length of the rays does not change the size of the angle as the rays on the app were changeable in length; and (f) students were easily able to discuss the angles with a partner as they could highlight and zoom in on the angle in the photograph.

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