Building Coherence in Circular and Complex Trigonometry with Inquiry-based Modeling

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The trigonometry is first framed on a right triangle, next on a unit circle with a parametrized pair of coordinates (r cos t, r sin t), and then on a complex frame, r (cos t + i sin t) unifying the Cartesian pair (Ekici, 2010). Students often struggle in understanding the connections and the transitions among triangle, circle, and complex trigonometry which serve as a critical mathematical foundation in many STEM fields. It is a challenge for students and teachers to coordinate the multiplicity of these trigonometric frames to develop coherent meanings. To support this transition, dynamic manipulatives using GeoGebra are here developed for student experimentation in modeling with modified circular and complex trigonometric functions. The results show that inquiry-based modeling using these multiple yet interconnected frames facilitate the emergence of coherence observed while validating these trigonometric models.

Keywords: inquiry-based learning, complex trigonometry, circle trigonometry

There is a need for a disciplined inquiry into the problem of teaching trigonometry towards building coherence across Euclidean, Cartesian and Complex frames in the teaching/learning practice with trigonometric functions (Ekici, 2010). Building coherence requires some deliberate focus on the connectedness of alternative mathematical frames in modeling periodic phenomena. Mathematical models can yield multiple solutions depending on the choice of mathematical frame, so the focus less on coming up with a specific answer and more on the validation of the model as framed (Anhalt & Cortez, 2015). Modified circular functions are here introduced here as a composition of sine and cosine functions with different periods. This approach is experimented here as a way to build advanced coherent perspective while modeling periodic functions in rich contexts such as sound modeling using alternative trigonometric frames.

Inquiry-based modeling with multiple mathematical frames is here adopted as a pedagogical strategy (Ekici & Plyley, 2018). GeoGebra applets are designed and offered by the author to help learners experiment and develop their models with dynamic manipulatives. Integrating such technologies for flipped learning provides extended support towards building connections within and between each trigonometric frame with critical reflections and anticipation. The emergence of coherence is observed in modeling with multiple trigonometric frames along a series of IBL lessons connected with a theme across the course. Collaborative action research is adopted to develop and refine an evidence based practice towards building coherence (Stringer, 2014).

The validation of the trigonometric models serves as a critical modeling stage examined across circle trigonometry, modified circular, and complex trigonometry. Through concept maps and reflections, the results of inquiry based modeling demonstrate that interpretation and validation of these multiple yet interconnected trigonometric models facilitate the emergence of coherence. This work informs the trigonometry practices in undergraduate and high school level providing an advanced perspective for teaching/learning trigonometry. The results show that inquiry-based modeling using these multiple yet interconnected frames facilitate the emergence of coherence observed while validating these trigonometric models. Reflections by learners provide evidence of their critical understanding of multiple trigonometric frames by observing how more simplicity is achieved in modeling with Complex frame as opposed to Cartesian.

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