Inquiry-Oriented Differential Equations as a Guided Journey of Learning: A Case Study in Lebanon

Samer Habre
Lebanese American University
Beirut - Lebanon

Integrating innovative pedagogical initiatives within the learning environment at the Lebanese American University in Beirut, Lebanon, has been set as a strategic goal. Active learning, as one medium of instruction, has seen widespread implementation in mathematics classrooms. This study reports on an inquiry oriented differential equations class offered in spring 2018. The focus is on the role of the curriculum in guiding students reinvent successfully key mathematical notions covered in any introductory differential equations class.

Keywords: Inquiry oriented differential equations; curriculum; guided reinvention.

Inquiry Based Learning (IBL), as an active learning medium of instruction, has seen integration in a variety of mathematics classes. An implementation of an inquiry-oriented curriculum is considered successful if it guides learners in reinventing the course key mathematical concepts. *Guided reinvention* (Freudenthal, 1991) allows "learners to come to regard the knowledge they acquire as their own private knowledge" (Gravemeijer & Doorman, 1999, p. 116). True to the nature of an inquiry-oriented learning environment, the Inquiry Oriented Differential Equations (IODE) course was developed by Rasmussen, Keene, Dunmyre, & Fortune (2017). The curriculum drew its inspiration from a dynamical systems approaches to differential equations (e.g. Blanchard, Devaney, and Hall (1998), and Hubbard and West (1991)), representing "a significant departure from conventional treatments of differential equations that emphasize a host of analytic techniques" (Rasmussen and Known, 2007, p. 190).

In spring of 2018 I taught an IODE course in my home institution. The material covered in the course was similar to a traditional course; however, learning was based on the four principles of IODE: Generating students' ways of reasoning, building on student contribution, developing a shared understanding, and connecting to standard mathematical language. The class was divided into seven groups consisting of 3 to 4 students each. Whiteboards, markers, and erasers were distributed to each group at the beginning of every class. To answer the research questions, *To what extent were students successful in reinventing the key concepts of the course and what obstacles were faced in acquiring the desired course outcomes*, I analyzed personal notes taken at the completion of each unit (14 units in all), snapshots of in-class students' work, copies of homework assignments (5 in total), and results of 5 online questionnaires posted on the Discussion Board of Blackboard Learn. Some recent empirical studies on students enrolled in IBL math-track courses have reported "greater learning gains then their non-IBL peers on every measure [such as] cognitive gains in understanding and thinking". (Lauren, S. L., M.L. Hassi, M. Kogan, and T.J. Wetson, 2014). While this study confirms these findings, reinventing knowledge proved to be cognitively demanding and in some cases required the intervention of the instructor to control and guide the discussion. Results also show departing from the conventional treatment of mathematical concepts was the main obstacle students faced.

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