Students' Experiences and Perceptions of an Inquiry-Based Model of Supplemental Instruction for Calculus

Karmen Yu
Montclair State University, NJ

The Inquiry-Based Instructional Support (IBIS) workshop model is part of an innovative degree program designed to prepare elementary mathematics teachers. The reason behind IBIS workshops was to support students enrolled in "historically difficult" mathematics courses, such as Calculus I and Calculus II. The design of IBIS workshop was framed and guided by Peer-Led Team Learning (PLTL) (Gosser & Roth, 1998) and Complex Instruction (Cohen, 1994). During workshop, students work in small groups and engage in "groupworthy" mathematical tasks that promote their conceptual understanding of Calculus topics (Cohen, 1994). A pilot study was conducted to evaluate the workshop structure and these tasks. In order to assess students' workshop experiences, follow-up interviews were conducted. Students' responses indicated that their workshop experiences helped to promote the development of their problem solving skills and highlighted the critical roles of thinking and reasoning in learning Calculus with understanding.

Keywords: [Inquiry-based learning, groupwork, Peer-Led Team Learning, Complex Instruction, Calculus]

Noyce @ Montclair is an innovative degree program designed to provide outstanding preparation for prospective elementary mathematics teachers. One of the enhancing components of this degree program is a series of Inquiry-Based Instructional Support (IBIS) workshops for students enrolled in "historically difficult" mathematics courses, such as Calculus I and Calculus II. Two existing models of academic support, Peer-Led Team Learning (PLTL) and Complex Instruction (CI), informed the development of IBIS. A pilot study was conducted in the fall of 2014 to examine what students learned from their participation in IBIS workshops.

Theoretical Framework

Peer-Led Team Learning (PLTL)

PLTL is an education intervention that included the use of well-trained peer leaders to facilitate small study groups into a part of the course structure (Gafney & Varma-Nelson, 2007). PLTL consists of six critical components: (1) workshop is integrated part of the course; therefore attendance is mandatory; (2) course faculties are closely involved in workshop organization and peer leader training; (3) all peer leaders are selected, well trained, and supervised; (4) workshop materials, also called modules, are challenging and appropriate; (5) workshops are designed for small groups of six to eight students; and (6) department and institution support, encourage, and acknowledge contemporary learning and teaching (Varma-Nelson, Cracolice, & Grosser, 2004).

Complex Instruction (CI)

CI is an instructional approach that utilizes cooperative groupwork for effective teaching in diverse classrooms. Complex Instruction emphasizes the value of groupworthy tasks, which are designed to facilitate the development of students' conceptual understanding. Initially, group members engage in training activities to begin to develop proper groupwork skills. Inside of a CI classroom, student interactions are viewed as a learning resource (Cohen, 1994).

Groupworthy Tasks

Buell, Greenstein, and Wilstein (*to appear*) proposed five considerations for designing problems and tasks that are groupworthy. The first consideration focuses on the high cognitive demand nature of tasks. This requires students to look beyond procedures and examine the underlying conceptual ideas. The second consideration refers to tasks with multiple entry points that allow students with different levels of understandings to get access of the tasks. With the third consideration, tasks should "open up the space" to allow for multiple pathways reach possible solutions. The fourth consideration suggests for tasks to be thought-revealing in order to promote discussions and collaboration among students. With the last consideration, tasks should be realistics to the students so the contexts are meaningful to them (Buell, Greenstein, & Wilstein, *to appear*). In order to develop workshop modules that focus on the development of students' conceptual understanding of Calculus, these five considerations were used to guide the development of our workshop modules.

Methods

Participants

There were nine students that attended IBIS workshops. These students were enrolled in Calculus I. Out of these nine students, four participated in the follow-up focus group interviews conducted at the end of the semester.

Data Collection

During the pilot study, each workshop session was videotaped and students' work on the workshop module was collected at the end of each workshop session. The follow-up focus group interviews conducted at the end of the semester were also videotaped. The purpose of this interview was to gain a better understanding of how student experienced and perceived IBIS workshops.

Data Analysis

The video interviews were transcribed. The interview transcripts were first individually coded by four researchers. The codes were then shared and discussed amongst the researchers to achieve consensus. The researchers took turns to interpret the codes and each interpretation was justified and explained.

Results

Instead of focusing on the correctness of the solutions, students were encouraged to think and reason about their approaches to the module problems. This experience is evident in the result of the interviews, as students' responses indicated that during IBIS workshop opportunities were provided for them to promoted the development of their problem solving skills, which is something that they found lacking in their Calculus classes. Students acknowledged that IBIS provided an environment that promoted, engaged, and focused on the development of their conceptual knowledge. Further, students identified that they need to think and reason in order to understand and learn Calculus. They also expressed that in IBIS, they are encouraged to be persistent to overcome obstacles and challenges. This resulted from students' interactions with their group members and the modules. Students were always encouraged to help each other while working on modules that have high cognitive demands.

Conclusion

The purpose of this study was to investigate what students learned from participation in IBIS workshops. The results suggest that workshop experiences helped to promote students' problem solving skills, conceptual understanding, and perseverance on solving challenging mathematical problems. Further research is required to examine the possible impacts that IBIS

has on both workshop students and peer leaders with a larger population. This is our first step to building a sustain inquiry-based support system for students to success in the Calculus sequence.

References

Buell, C. A., Greenstein, S., & Wilstein, Z. (*to appear*). A learning theory approach to democratizing access to inquiry: Two principles, four implications, five considerations. Manuscript accepted for publication.

Cohen, E. G. (1994). Designing groupwork: Strategies for the heterogeneous classroom (2nd ed.). New York, NY: Teacher's College Press.

Gafney, L., & Varma-Nelson, P. (2007). Evaluating Peer-Led Team Learning: A study of long-term effects on former workshop peer leaders. *Journal of Chemical Education, 84*(3), 535-539.

Gosser, D. K., & Roth, V. (1998). The workshop chemistry project: Peer-Led Team Learning. *Journal of Chemical Education, 75*(2), 185-187.

Varma-Nelson, P., Cracolice, M. S., & Grosser, D. K. (2004). *Peer-Led Team Learning: A student-faculty partnership for transforming the learning environment.* Paper presented at the Invention and Impact: Building Excellence in Undergraduate Science, Technology, Engineering, and Mathematics (STEM) Education, Washington, D.C.