

Roles of Teacher's Revoicing in an Inquiry-Oriented Mathematics Class: The Case of Undergraduate Differential Equations

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Recently mathematics educational researchers have taken an increasing concern in the teacher's discursive move. According to Krussel, Edwards, and Springer (2004), discursive move is defined as a deliberate action taken by a teacher to participate in or influence the discourse in the mathematics classroom. In particular, this paper focuses on the teacher's revoicing because it is one of discursive strategies that it often occurs in the teaching of mathematics, but which is not thoroughly investigated. Forman, Larreamendy-Joerns, Stein, and Brown (1998) highlighted revoicing as a critical feature of a teacher's discourse by which s/he orchestrates students' discussion. Also, O'Connor and Michaels (1996) focused on the notion of revoicing to illustrate that the instructional process depends upon the skillful orchestration of classroom discussion by the teacher.

Historically, differential equations have been invented as a language to express the law of the nature. However, the conventional teaching and learning practice of differential equations heavily relies on drill and practice. It can hardly be said that students learn the historical spirit of differential equations. The development of the Inquiry-Oriented Differential Equations (IODE) approach has been initiated by the reflection on how to reform teaching differential equations in order for students to learn differential equation as a language for talking about their world. It has been shown that the IODE approach positively contributes to students' conceptual understanding, problem solving, retention, justification, and attitudes toward mathematics (Ju & Kwon, 2006; Kwon, et al., 2004; Kwon, Rasmussen, & Allen, 2005, Rasmussen, Kwon, Marrongelle, Allen, & Burtch, 2006, Yackel & Rasmussen, 2002). However, we still have to resolve the notorious dilemma of an inquiry-oriented mathematics class for teachers, that is, "how to teach without teaching?" In this research, we have struggled with this dilemma by deeply looking at how a teacher uses language, specifically revoicing, to guide students in the reinvention of mathematics.

The data for this study came from four IODE classes about phase portrait of the system of differential equations with initial value from a large state university in the United States in 2005. Each class was video-recorded and whole utterances of both teacher and students were transcribed. Through the analysis of the data, we identified four categories about teacher's discursive move: revoicing; questioning/requesting; telling; managing. There are sub-codes depending on the forms or roles that each type of discursive move takes. For example, revoicing has four sub-codes: repetition, rephrasing, expansion, and reporting.

As the result of the analysis, we found that teacher's revoicing constitutes a major part of teacher's utterances in class and, most importantly, it carries out very critical functions as following;

Revoicing as a binder Teacher's revoicing works to signal that a mathematical position has been identified and that a speaker is aligned with a certain position. In addition, a teacher uses revoicing to provide an opportunity for students to bring up diverse mathematical positions for the negotiation of mathematical meaning. In this way, a teacher's revoicing enables students to attend to critical ideas in order to generate more comprehensive mathematics by connecting diverse perspective.

Revoicing as a springboard Teacher's revoicing recruits students' attention to a specific claim and prompts the speaker to clarify and elaborate one's own claim. Thus a teacher's

revoicing scaffolds students to clarify, to elaborate, and to extend their mathematical positions through reflection. Moreover, the concepts highlighted by a teacher through revoicing come up in the small group discussion to shape students' follow-up inquiry. Also, in revoicing, a teacher can demonstrate the cultural way of doing mathematics to support students' transformation as practitioners of mathematics. In this regard, teacher's revoicing contributes to lift students' practice of mathematics and ultimately to support their socialization into the cultural organization of mathematics community.

Revoicing for ownership Teacher's revoicing makes reference to which the mathematical position belongs and helps every classroom participant make sense of it. Also when the mathematical concepts or contents that the teacher wants students to discuss about do not appear fully, revoicing enables a teacher to reveal available mathematical resources rising in the voices of students. As a consequence, mathematics is represented as being collectively constructed by the course participants themselves instead of being given by the teacher. In this regard, revoicing creates a sense of classroom as a community of practice and a sense of mathematics as their own practice.

This article provides an understanding of how a teacher can invite students to the classroom practice of mathematics and engage with students in the collective construction of mathematics. This study of revoicing can be extended by investigating the function of revoicing in conjunction with other verbal forms such as questioning in order to provide useful guidance for teachers how to effectively fulfill their role in an inquiry-oriented mathematics class.

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