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Meta-didactical Slippages in a Ninth Grade Mathematics Classroom: A Paradox of Teaching

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Abstract
This paper examines (a) the nature of meta-didactical slippages that occurred in a ninth grade predominantly African American mathematics classroom; and (b) how these meta-didactical slippages affect students’ conceptual understanding on a unit of ninth grade mathematics. A qualitative case study that employed ethnographic techniques of data collection and analysis was conducted. The theory of didactical situations in mathematics (Brousseau, 1997) served as the lens that grounded the interpretation of the data. The study found four themes, which illustrated the nature meta-didactical slippages: (a) over-teaching, (b) situational bypass, (c) language and symbolic representation, and (d) the design of didactical situations.

Keywords: Mathematics Education, Didactical Situations, Slippages, Qualitative Case Study

Mathematics teaching is a complex practice, because teachers have to balance multiple goals and constraints as they decide “how to respond to students’ questions, how to represent a given mathematical idea, how long to pursue discussion of a problem, or how to make use of available technologies to develop the richness of an investigation” (Martin & Herrera, 2007, p. 18). Mathematics teachers are also responsible for developing students’ mathematical reasoning skills. Mathematical reasoning and learning occurs within a context that is determined by a set of implicit and explicit rules, circumstances, and interactions among several systems such as the teacher system, the student system, and the milieu (Brousseau, 1997). Despite these complexities, a significant responsibility is placed on the teacher to ensure that students are able to do mathematics. Thus mathematics teachers have to create meaningful didactical situations in order to facilitate the process of doing mathematics. Nevertheless, it is in the didactical situations that complexities and inherent difficulties of the teaching and learning process occur. Meta-didactical Slippage is one such difficulty.

Meta-didactical Slippage is defined as the replacement of a teaching situation by one of its meta situations (Brousseau, Brousseau, & Warfield, 2009). This phenomenon that occurs from the interplay of relationships and constraints between the teacher, students, and mathematical content, may produce certain unwanted effects. Although this effect is inappropriate for the learning, it is often inevitable, and sometimes unknown (Brousseau, 2008; Schoenfeld, 1988). In this study, I argue that in order to improve students’ performance in problem solving situations, we need a better understanding of the didactical situations in the mathematics classroom. Consequently, the purpose of this study was to understand
the nature of meta-didactical slippages and how meta-didactical slippages occur in a ninth grade mathematics classroom.

**Research Questions**

The following question guided the study:

What is the nature of meta-didactical slippages that emerge in the practice of teaching mathematics?

**Theoretical Perspective**

This study draws on Guy Brousseau’s theory of didactical situations in mathematics (TDSM) (Brousseau, 1997). This perspective holds that meanings are constructed in a social situation, and that meanings change from culture to culture and from individual to individual. TDSM helped me to isolate particular meanings that teachers and students construct in the didactical situations in the mathematics classroom.

**Study Design**

This study was a descriptive, qualitative, case study conducted in one, ninth grade mathematics classroom over a 15-week period. A descriptive case study was appropriate because the primary goal was to describe the phenomenon as it occurred in its natural environment. According to Yin (2009) a rationale for selecting the case study is when the researcher is studying contemporary events but “the relevant behaviors cannot be manipulated” (p. 11). Furthermore, the case study according to Hays (2004) seeks to answer focused questions by producing in-depth descriptions and interpretations over a short period of time. Thus, in order to probe beneath the surface of the didactical situations, and to get a better understanding of meta-didactical slippages, the qualitative case study methodology is well suited.

Qualitative researchers use multiple methods. The use of multiple methods reflects the researchers’ aim to secure an in-depth understanding of the phenomenon in question. According to Denzin and Lincoln (2005), the combination of multiple methodological practices, empirical materials, perspectives, and observers is understood as a strategy that adds depth, rigor, breadth, complexity, and richness to an inquiry. Since didactical situations in the mathematics classroom are examples of a complex situation that involves multiple representations, the qualitative case study is an ideal research methodology.

**Data collection and analysis.** To answer the research question proposed, I used four data collection techniques: (a) collection of document artifacts, which included student work samples and teacher lesson plans; (b) direct observation; (c) open ended interviews, conducted with the teacher; and (d) researcher introspection. Data collection instruments include the interview protocol, the observation log, and the documents artifacts.

In order to achieve a more fine grained analysis two analytic techniques were used: ethnographic analysis using Spradley’s (1998) model and discourse analysis using Gee’s (2011) model. Episodes from the classroom were coded using the TDSM to guide the construction of codes. A summary of the analytic procedure is shown in Figure 1. In order to maintain focus throughout the analysis, I asked the following questions of the data: (a) what is the genesis of these slippages? (b) how may this slippage be identified? (c) what are their attributes? (d) what are their affordances?
(e) can they be predicted? and (f) how can they be controlled if possible? I used a combination of hand coding and computer qualitative software coding. I used the ATLAS.ti qualitative software to manage the data files and to retrieve codes quickly. A summary of the analytic procedure is shown in Figure 1.

Figure 1. Summary of analytic procedure followed in this study.

Results

In this study four themes emerged as illustrative of the nature of meta-didactical slippages: (1) over-teaching, (2) situational bypass, (3) language and symbolic representation, and (4) the design of didactical situation. Each theme emerged as an instance of meta-didactical slippage. The findings further suggest that meta-didactical slippages manifest as paradox of the teaching endeavor. The findings showed that the mathematics classroom is a very complex and highly nuanced community. What is generally, considered to be good teaching could potentially become an obstacle to students’ learning.

Implications and Recommendations

Whereas a single case study cannot provide a sound basis for the practice of teaching and learning in the mathematics classroom, this study would suggest that teachers should be more purposive in how and when they intervene in problem situation in the mathematics classroom. This is so that they do not replace an initial mathematical situation that would have permitted an authentic activity on the part of the student, by a study of the mathematical circumstances, or by reducing the cognitive demand of the task. The study suggests that often the best efforts of the teacher could undermine the instructional goal for the students.
A recommendation of this study is that the results of research on didactical situation be disseminated to mathematics teachers. This should be included in professional development for mathematics teachers so that they can become aware of the phenomenon of meta-didactical slippages. This increased awareness of the phenomenon should influence teachers’ didactic decisions as they plan and implement mathematical lessons. In this way, the teacher is more sensitive to resist the desire to take all mathematics activities as an object of teaching. Finally, school districts should provide professional development for mathematics teachers to learn how to design and implement didactical situations.
References