Using the flipped classroom model of instruction to explore teaching and learning activities in mathematical education for engineers: An activity theory perspective

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THE FLIPPED CLASSROOM MODEL OF INSTRUCTION

The main concept of Flipped Classroom (FC) is to invert, or flip, the content of teaching in terms of what is done during the homework phase, compared to the activity in the class with the teacher. Traditionally, the students at higher education attend a lecture, accompanied with tasks to solve at home or in a colloquium arranged by the University. The FC model will alter this completely, giving the students the opportunity to watch the lectures at home using pre-recorded videos. When attending class, instead of listening to a lecture, the students spend the time in a more dialogue-based problem-solving activity. To capture this complexity, the poster proposes a conceptualization of FC within the Activity Theory Framework.

THEORETICAL FRAMEWORK

A variety of theories has been used to conceptualize FC, such as constructivism, ZPD, Bloom's taxonomy, or cognitive load theory. In addition, the research literature uses mostly quantitative methods to analyze the effectiveness of FC in comparison to traditional classroom, or to investigate participants' perceptions of FC. As a result, most studies fail to capture the complexity of the FC model of instruction. The complexity of FC resides in introducing a new instructional culture into classroom, using new mediating artifacts, new rules and new division of labor within the community of teachers and students. Furthermore, in contrast to traditional classroom, FC puts more emphasis on homework, which is better incorporated into classroom activities by means of group work or collaborative activities (Bergmann, 2012). Clearly, to understand the complexity of FC, there is a need for a theory that covers all components of FC. Activity Theory (AT) provides such an overall framework for analyzing human activity through a socio-cultural lens (Engeström, 2010). Due to its adaptability, the theory can be used to conceptualize FC and mathematical activities as a product of social interactions and socio-historical needs (Roth and Radford, 2011). AT is a potentially powerful tool to conceptualize FC as an activity system, and to investigate how engineering students engage in group work activities, and how they use videos and quizzes to shape the mathematical discourse. Furthermore, AT is well suited to analyze the contradictions that arise within the elements of FC. As a result, we use AT as an overreaching theoretical framework to analyze the relationships between the elements of FC (subjects, objects, mediating artifacts, community, division of labor, and rules). To capture the

specificities of FC, we need middle-range theories to analyze the mathematical discourse that evolves in- and out-of-class activities, the types of interactions that occur in classroom, and the way the students use videos and quizzes.

RESEARCH QUESTIONS

Our research questions address both in- and out-of-class activities of FC:

1. What characterizes the students' use of videos and quizzes?
2. To what extent is the knowledge gained from the videos and quizzes integrated into classroom activities?
3. What types of interactions occur in classroom sessions?
4. What types of mathematical discourse emerge from students activities and how does it evolve and change over time?

We are also interested in the general question on how the students and teachers apprehend to the new set of rules that govern FC, that is, the new way of studying using videos and discussion in groups.

METHODOLOGY

We suggest performing an initial pilot study on the cohort following the study year of 2016/2017. Gathering experience from this initial study, while also being engaged in creating the study material (videos, quizzes and in-class activities), we would be ready for the main case study in the study year of 2017/2018. Because we consider this research work through the lens of Activity Theory, the study will focus on qualitative research methods. We will use an ethnographical approach to data gathering by means of video-filming, tape-recording, and interviews, following the same group of students over a whole year (Bryman, 2012). To analyze the data collected, we perform transcriptions to extract the mathematical discourse, explore the interactions in classroom, and other methods to make sense of video use.

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