Chapter 10

Flipped Classroom, Cognitive Flexibility Theory, and Cognitive Operators of Complexity: Developing TPACK in Pre-Service Teacher Education

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ABSTRACT

Researchers have presented several training models for teachers with the goal of developing TPACK. However, it is necessary to investigate how learning theories can help in the elaboration of these models. It is also essential to use a theoretical framework that provides guidance on how to deal with this complexity involved in TPACK and teacher training. This problem motivated the investigation of how a course based on a model that uses the cognitive flexibility theory (CFT), the cognitive operators of complexity and implemented in the flipped classroom can help in the development of the TPACK. The investigation was carried out through a case study. Participants were pre-service teachers at a Brazilian university. Data analysis allowed to identify that the course helped in the development of the TPACK by the teachers and to determine the positive aspects and the difficulties faced in the implementation of the proposed model.

INTRODUCTION

The transformative potential of technology use in education has been extensively discussed in the literature. Consequently, it is essential to investigate the necessary knowledge that the teacher must have to facilitate this transformation in the classroom. To contribute to the discussion, Mishra and Koehler (2006) propose the TPACK (Technological Pedagogical Content Knowledge) as a model that highlights the interaction between the knowledges necessary for effective integration of technology in the educational process.

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Despite the divergences on issues of epistemological nature and validity of the constructs (Archambault & Barnett, 2010; Cox & Graham, 2009; Graham, 2011; Kabakci Yurdakul, Odabasi, Kilicer, Coklar, Birinci, & Kurt, 2012; Saad, Barbar, & Abourjeili, 2012), TPACK is considered a promising framework that has led to an emergence of a significant number of research examinations (Chai, Koh, & Tsai, 2013; Rosenberg & Koehler, 2015). In relation to teacher training, the researchers have presented several TPACK training models aimed at different audiences in different contexts (Han, Eom, & Shin, 2013; Jang & Tsai, 2013; Koh & Divaharan, 2013; Lee & Kim, 2014; Mouza, Karchmer-Klein, Nandakumar, Yilmaz Ozden, & Hu, 2014). Even with the relative variety of models, because the complexity involved in TPACK and teacher training, it is important to use a theoretical framework that assists and provides guidance on how to deal with the complexity. In a previous work (Andrade, Coutinho, & Oliveira, 2017), the authors proposed a training model for TPACK development that used the principles of Cognitive Flexibility Theory (CFT) (Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987), the Cognitive Operators of Complexity (Mariotti, 2007; Morin, 2005) and implemented through the Flipped Classroom. However, there is a need for empirical studies to investigate the effectiveness in the development of teachers’ TPACK and the feasibility of implementing the proposed model.

Thus, in this work, a case study is presented based on a course planned according to the training model proposed by Andrade, Coutinho, and Oliveira (2017) to answer the following question. How does a course based on a training model that uses the principles of CFT and Cognitive Operators of Complexity implemented through a Flipped Classroom support the development of TPACK in a pedagogy course in teaching science? Besides this broad question, additional questions were investigated through the analysis of the empirical data:

- How did participation in the proposed course develop the teachers’ TPACK?
- How did the teachers’ transfer their knowledge from the learning situation to other situations as indicated by the CFT?
- What were the advantages and difficulties when implementing a course based on the proposed model?

BACKGROUND

TPACK has its origins in the PCK (Pedagogical Content Knowledge) framework proposed by Shulman (1986). PCK is the integration of pedagogical knowledge with the knowledge of the content that the teacher uses to represent the content, making it comprehensible to students (Shulman, 1986). However, the concept of PCK needed to be expanded to account for understanding the educational uses of the new technologies (Angeli & Valanides, 2009). From this need, Koehler and Mishra (2006) included the Technological Knowledge to the PCK elaborating the concept of TPCK, currently TPACK, representing a deep interaction between content, pedagogy, and technology.

TPACK is typically represented by a Venn diagram (Figure 1) describing the fundamental knowledge of the model and inserted in a circle that represents the context.

The following brief description presents the constructs that constitute TPACK (Table 1). Sources for the description include Coutinho (2011), Graham (2011), and Mishra and Koehler (2006).

In the literature, it is possible to find a considerable number of studies on training models for teachers’ TPACK development in both in-service and pre-service and in several areas of knowledge (Han,
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