



Science teachers' conceptions of teaching and learning, ICT efficacy, ICT professional development and ICT practices enacted in their classrooms

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HIGHLIGHTS

- Several precursors that might impact ICT practices in classrooms were examined.
- Data were gathered from 303 science teachers and analyzed by using PLS-SEM.
- Constructivist conceptions exerted moderate effect on teachers' sense of efficacy.
- Teachers' sense of efficacy increased their ICT efficacy.
- Teachers' ICT training increased their tendency to use ICT in the classroom.

ARTICLE INFO

Article history:

Received 14 May 2017

Received in revised form

17 March 2018

Accepted 28 March 2018

Keywords:

Science and technology education

Teacher conception

Sense of efficacy

ICT efficacy

ICT professional development

Partial Least Squares - Structural equation modeling (PLS-SEM)

ABSTRACT

This study assessed several precursors that might be connected to Information and Communication Technology (ICT) practices enacted in classrooms, namely, science teachers' conception of traditional versus constructivist teaching and learning, their sense of efficacy, ICT efficacy, and ICT professional development. Data were gathered from 303 science teachers. According to the results, constructivist conceptions exerted moderate effects on the teachers' sense of efficacy constructs, which in turn increased their ICT efficacy. Additional results pointed to the positive mediation role of teachers' ICT professional development in linking their ICT efficacy to ICT use for constructivist activities in their science classroom.

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1. Introduction

The way teachers use their beliefs about knowledge and learning to teach and the beliefs they bring to their professional experience may serve as barriers or facilitators of learning, shape their practice, and serve as heuristics for teachers embedded in the ever-changing contexts of classrooms (Admiraal et al., 2017). The huge shift from traditional to constructivist approaches in science education context has turned this field of research on teachers' conceptions of teaching and learning into a valuable avenue that

may shed light on their educational practices. This study uses the new curriculum of science and technology education for primary and secondary schools in Israel (Center for the Advancement of Scientific and Technological Education (CASTE, 2007); Israeli Ministry of Education (IME, 2015) to delve deeper into this field of research by assessing several precursors that might contribute to teachers' actual behavior in the science classroom, in terms of using Information and Communication Technology (ICT) for constructivist activities.

The new curriculum outlines the pedagogical approach to teaching science and technology education by shifting the focus from traditional-based to student-centered approaches. It seeks to engage students with scientific and technological activities through the implementation of innovative pedagogical approaches that

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characterize the teaching of science and technology for the 21st century. The curriculum designers put an emphasis on the online learning environment, and perceive it as an integral part of the curriculum: “The online activities are intertwined with the teaching/learning sequences, enrich and diversify the teaching processes, and make them more challenging ... these activities include: learning objects, simulations and research projects that are integrated into the instructional units” (CASTE, 2007, p. 37).

Although the new curriculum reflects the shift from traditional to constructivist approach in science education, several researchers (Da-Silva, Ruiz, & Porlan, 2006; Donnelly, McGarr, & O’Reilly, 2014; Horn, Nolen, & Ward, 2013) express their concerns about the potential of constructivist-based curricula to promote particular practices of teaching and learning used in classrooms and point to a gap between actual activities practiced in the classroom and current reform recommendations. This phenomenon is explained by the conservatism that exists in the teaching profession. The researchers suggest that teachers’ conceptions and beliefs are deeply rooted in personal histories about the nature of knowledge and knowledge acquisition acquired through one’s own education learning experiences. Based on this premise, the present work will measure science teachers’ conception of traditional versus constructivist teaching and learning, their sense of efficacy, ICT efficacy, and ICT professional development, as possible constructs that might be connected to their tendency to enact ICT practices in their classrooms. This study might support key stakeholders with insights into teachers’ psychological and personal aspects that might be connected to science teachers’ tendency to use these activities in their classrooms.

1.1. Literature review

1.1.1. Teachers’ conceptions of teaching

Conceptions of teaching are viewed as instructional ideas about the nature of the content to be taught, about how to teach the content to students and about how students learn the content (Da-Silva et al., 2006). Conceptions of teaching are often classified as dimensions, orientations and complex sets of propositions, teachers’ preferred ways of teaching and learning including the meaning of these ways and the roles of teachers and pupils (Chan & Elliott, 2004; Koballa, Glynn, Upson, & Coleman, 2005). Chan (2009) classifies conceptions of teaching and learning using two broad categories: quantitative and qualitative. The quantitative conception refers to the quantity of knowledge acquired and reproduced, also known as the teacher-centered instruction. This type of approach is focused on the teacher’s input and on assessment in terms of how well the students absorb the material taught. Course descriptions refer mainly to the content of the course that would be covered in lectures. The teacher is perceived as a transmitter of the knowledge, and the student as the recipient of the knowledge (Chan & Elliott, 2004). In contrast, the qualitative conception refers to deep understanding of the knowledge - associated with the constructivist view of learning, and with the student-centered instruction. A constructivist teacher makes the learning more relevant to the students’ needs by creating a context for learning in which students can become engaged in discovery, collaboration and critical thinking activities (Cheng, Chan, Tang, & Cheng, 2009).

Several studies have pointed to symmetric relationships between teachers’ conceptions of teaching and learning and their actual practices in the classroom. For example, Zhang and Liu’s (2013) study revealed that constructivist teachers favored student participation, interactive class, while teachers who held traditional beliefs have focused attention on drill and practice, rote memorization, and teacher authority.

Others have pointed to a gap that exists between classroom

activities and current reform recommendations. For example, Donnelly et al. (2014) stipulated that although associated with constructivist learning environments, teachers and students bring expectations to the inquiry-based classroom that are entrenched in traditional practices. Their study indicated features of the traditional approach inside the classroom that impact on inquiry-based instruction, such as predominant teacher monitoring on task completion over task understanding, lack of student engagement in ownership of scientific ideas, and prevailing norms of what effective teacher questioning is. This use of traditional-based instructional methods represents an important limiting factor in the capacity of teachers to create a constructivist-based learning environment.

Teacher beliefs have also been shown to be closely associated with lesson planning, assessment, and decision making during classroom interactions (Pajares, 1992). Thus a close link exists between what teachers do in their classrooms and their beliefs as exemplified by Enyedy, Goldberg, and Welsh (2005) who discussed teaching dilemmas which arise for teachers as their identities and practices intersect and at times conflict. The authors argue that practices and outcomes are important, but they are limited aspects of what is needed to be considered when attempting to understand the complexities of teaching and learning. Therefore, they suggest examining teachers’ multiple identities in relation to their implementation of a science curriculum that might provide a rich account for the implementation of a science curriculum.

The current study adds to those efforts by focusing on two additional factors that might mediate the connection between teachers’ conception of teaching and their actual classroom activities namely, their sense of efficacy, ICT efficacy, and their involvement in ICT professional development activities.

1.2. Teachers’ sense of efficacy and ICT efficacy

Perceived self-efficacy is defined as “people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Such beliefs produce these diverse effects through four major processes. They include cognitive, motivational, affective and selection processes” (Bandura, 1994, p. 71). Moreover, self-efficacy is not only about the multiplicity of skills that the person has, but it is also related to the belief on what he or she can accomplish with these skills in a given situation (Bandura, 1997).

A teacher’s efficacy belief has been defined as a judgment of the teacher’s capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be unmotivated (Bandura, 1977). Teacher efficacy has proved to be powerfully related to many meaningful educational outcomes such as instructional behavior. Accordingly, it is one of the most studied aspects of the classroom context. Tschannen-Moran and Woolfolk-Hoy (2001) assert that teachers’ efficacy beliefs relate to their behavior in the classroom and affect the effort they invest in teaching and the goals they set. Teachers with a strong sense of efficacy are more open to new ideas and are more willing to experiment with new methods to better meet the needs of their students. Greater efficacy enables teachers to be more positive and responsive to students and promote positive classroom environments thus, impacts the type of the learning environment a teacher provides (Miller, Ramirez, & Murdock, 2017). Gurbuzturk and Sad (2009) have associated teachers’ sense of self-efficacy with their traditional versus constructivist educational beliefs. Their study revealed that participants’ professional self-efficacy levels were moderately over average and they had both constructivist and traditional beliefs, however, constructivist beliefs were found moderately more

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