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## Mathematics teachers' attention to potential classroom situations of argumentation

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### ABSTRACT

This study investigates secondary school mathematics teachers' attention to potential teaching situations that encourage argumentation. A group of 17 seventh grade teachers were asked to choose three tasks from a textbook they all use in teaching, which, in their view, have the potential to encourage argumentation, and then to justify their choices. Analysis of the teachers' responses revealed categories that fall into three dimensions of attention: (1) Attention to the mathematics in which the argumentation is embedded, focusing on three aspects: the mathematics inherent in the task; the mathematics related to the teaching sequence of which the task is a part; and the meta-level principles of mathematics; (2) Attention to socio-cultural aspects related to argumentation; and (3) Attention to students' ways of thinking which might be revealed by the task. Analysis of each response revealed four types of combinations of dimensions of attention: a. Responses attending to all three dimensions; b. Responses attending solely to the mathematics inherent in the task; c. Responses attending only to the socio-cultural dimension; and d. Responses refers to none of these dimensions. Analysis also found that responses of the same teacher were of the same type of combination. The findings were interpreted in light of theory and practice and suggestions for additional research emerged.

### 1. Introduction

Research in mathematics education acknowledges the importance of engaging students in activities of generating and critiquing arguments (Balacheff, 1991; Ball & Bass, 2003; Krummheuer, 2007; Yackel & Hanna, 2003). For supporting students to engage in such activities, the teacher needs to possess knowledge of various aspects associated with argumentation (Mueller, Yankelewitz, & Maher, 2014; Staples, 2014; Yackel, 2002). This includes the kinds of justifications accepted in mathematics, students' common tendencies and difficulties, and the conditions essential to establish a classroom environment that fosters argumentation. While there has been considerable research which focuses on argumentation; limited research has specifically focused on teachers' knowledge and practice in the context of argumentation (Kosko, Rougee, & Herbst, 2014; Mueller et al., 2014; Yackel, 2002). Considering that such knowledge impacts the way in which this key practice is implemented in the classroom (Conner, Singletary, Smith, Wagner, & Francisco, 2014; Kosko et al., 2014), it appears important to make it the focus for investigation. This study addresses this direction. It explores what teachers attend to when asked to choose mathematical tasks that they view as having potential to encourage class argumentation. Analysis of the justifications teachers provided to defend their choice of tasks revealed several dimensions of teacher attention to potential classroom situations of argumentation. These dimensions provide a lens through which we may learn about

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teachers' prior knowledge of argumentation.

## 2. Theoretical background

### 2.1. Argumentation in mathematics

There are various definitions of argumentation in the literature. In this work we follow a commonly accepted definition in educational research suggested by van Eemeren et al. (1996), i.e., argumentation is “a verbal and social activity of reason aimed at increasing (or decreasing) the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions intended to justify (or refute) the standpoint before a rational judge” (p. 5). This definition involves building claims, providing evidence to support the claims, and evaluating this evidence to judge the validity of the claims. It positions argumentation in a social space, and if incorporated as part of classroom discourse, it affords a venue for the articulation of alternative ideas, reflection, and reasoning (Schwarz, Hershkowitz, & Prusak, 2010). Within mathematics, it is quite common to consider that logical necessity should lead to the evaluation of arguments. In the mathematics classroom, the kinds of justifications that are acceptable are formed by negotiating socio-mathematical norms (Yackel & Cobb, 1996). The definition by van Eemeren et al.'s (1996) forms a foundation in the literature for common descriptions of argumentation that is ‘fruitful’ for learning which refers to “balances between critical reasoning and collaborative knowledge construction” (Asterhan & Schwarz, 2016, p. 167). This type of argumentation – called *deliberative argumentation* (Felton, Garcia-Mila, & Gilabert, 2009) – is characterized by critically and respectfully listening to others’ ideas, identifying the weaknesses and strengths in each idea, and searching for alternative ideas. Particularly in mathematics education, studies suggest that students’ participation in such practice promotes meaningful understanding and deep thinking (Douek, 1999; Hershkowitz & Schwarz, 1999; Weber, Maher, Powell, & Lee, 2008).

### 2.2. The role and challenges of the teacher in facilitating argumentation in the mathematics classroom

Research focusing on argumentation in the mathematics classroom has indicated that in spite of its importance for learning mathematics, the implementation of argumentation in the mathematics classroom is not yet a common practice (Bieda, 2010; Bleiler, Thompson, & Krajcevski, 2014; Staples, Bartlo, & Thanheiser, 2012). Researchers have investigated aspects of the mathematics classroom that might promote argumentation and the role of the teacher in facilitating it (e.g., Ayalon & Even, 2016; Conner et al., 2014; Douek, 1999; Forman, Larreamendy-Joerns, Stein, & Brown, 1998; Mueller et al., 2014; Yackel, 2002). These studies demonstrate that the teacher plays an essential role in establishing norms and standards for mathematical argumentation in the classroom (e.g., Ayalon & Even, 2016; Forman et al., 1998; Mueller et al., 2014; Yackel, 2002). Teachers’ roles include listening to students, encouraging students to establish claims and justifications and to critically consider different arguments, explicating the argumentation basis of students’ claims, and supplying support that was either omitted or implicit. The teacher has to maintain a balance between the need to teach certain content, on the one hand, and the strategy of affording opportunities for students to construct their knowledge in autonomic ways, on the other (Kosko et al., 2014). Mueller et al. (2014) also pointed to certain connections between certain types of tasks and teachers’ particular moves that can enhance argumentation in the classroom, so teachers can plan effective moves and questions in advance. Moreover, as a representative of the mathematics community, the teacher plays an essential role in negotiating with the students the kinds of justifications that are acceptable in the classroom, possibly by negotiating socio-mathematical norms (Yackel & Cobb, 1996) and by providing examples and counter-examples when necessary (O’Connor, 2001). This is especially important, since research points to different kinds of justifications that are used by students, which often depart from the norms of the field (e.g., Chazan, 1993; Harel & Sowder, 2007; Knuth, Choppin, Slaughter, & Sutherland, 2002). These studies show that students, even undergraduate mathematics majors, tend to generate empirically based justifications instead of constructing deductive proofs (Fischbein & Kedem, 1982).

The role of the teacher is therefore not simple at all. Whereas research on argumentation is rapidly growing, little research specifically focuses on teachers’ knowledge associated with argumentation (Ayalon & Even, 2016; Kosko et al., 2014; Mueller et al., 2014; Yackel, 2002). Findings from existing research demonstrate that teachers can have difficulties in supporting the incorporation of argumentation into classroom practice (Ayalon & Even, 2016; Bieda, 2010). For example, teachers can have difficulties engaging students in constructing and confronting arguments (e.g., Ayalon & Even, 2016). Moreover, teachers’ interpretation of facilitating mathematical argumentation can be not aligned with what reformers in mathematics education envision, for example thinking that mathematical argumentation can occur with relatively little scaffolding by the teacher (Kosko et al., 2014). Across these studies, teachers appear to struggle with various aspects of argumentation. However, such research is in its infancy, and as a field, we need to develop a more profound and comprehensive understanding of teachers’ knowledge and practice of argumentation. Such understanding may contribute to devising appropriate guidance for teachers.

### 2.3. Teachers’ choice of mathematical tasks as a tool for exploring teacher attention to potential classroom situations of argumentation

For this study, we used the construct of *attention* (Mason, 1998) to ask what teachers *attend to* when they choose tasks with the explicit intention to enhance argumentation in their classrooms. Attention, according to the Merriam-Webster dictionary, is “the act or state of applying the mind to something” (Attention, 2017). In mathematics education, research has focused on *teachers’ attention* as an object for both investigation and development, under the premise that it shapes teachers’ actions and practices (Mason, 2008; Miller, 2011). Findings of research that has focused on teachers’ attention to classroom situations have indicated that teachers,

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