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Using contextualized tasks to engage students in meaningful and worthwhile mathematics learning

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A R T I C L E I N F O

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A B S T R A C T

A teacher's choice and use of tasks are major determinants of the nature and quality of students' learning. Teachers of 11–15 year-olds in a project called Task Types and Mathematics Learning used a range of contextualized tasks and reported affordances and disadvantages of the use of such tasks. We offer a rationale for the use of contextualized tasks, examples of tasks providing insightful student thinking, and teacher feedback on affordances and constraints of the use of these tasks. For three different types of tasks, students provided feedback on the relative extent to which they enjoyed, learned from, and found difficult each type of task, respectively. Finally, we report on a follow up project which studied teacher actions supporting persistence on cognitively demanding contextualized tasks. Findings inform our understanding of the teacher's role in providing engaging and worthwhile mathematics for all students.

1. The important role of task design for mathematics classrooms

Many commentators have argued that the decisions teachers make when choosing tasks are critical. Christiansen and Walther (1986) argued that the mathematical tasks that are the focus of classroom work and problem solving determine not only the level of thinking by students, but also the nature of the relationship between the teacher and the students. These views were endorsed by Hiebert and Wearne (1997) and Ruthven, Laborde, Leach, and Tiberghien (2009).

Further, Francisco and Maher (2011) claimed that affording students the opportunity to work on complex tasks, rather than scaffolding a series of more straightforward problems, enhanced mathematical reasoning in students. In a study of mathematical reasoning of fourth and sixth grade students in an urban school district in the USA, Yankelewitz, Mueller, and Maher (2010) found that carefully designed tasks could enable students to reason effectively and in targeted ways, and could "assist them in learning to use various arguments as they engage in mathematics" (p. 84). Mueller, Yankelewitz, and Maher (2010) contended that careful attention must be paid to the presentation of the task, as well as the variety of learning opportunities it provides.

Based on extensive research on the impact of mathematical tasks on student learning in the United States of America, a model of task identification and use was presented in a diagram by Stein, Grover, and Henningsen (1996; see Fig. 1).

The model proposed that the features of the mathematical task as set up in the classroom, and the cognitive demands on students, are informed by the mathematical task as represented in instructional materials. These are, in turn, influenced by the teacher's goals, subject-matter knowledge and knowledge of students. This then informs the mathematical task as experienced by students which creates the potential for their learning. Teachers determine the learning goals which they hope to have their students achieve and the types of mathematical actions in which the students will engage, noting the levels of student readiness – choosing the appropriate tasks is the next step. In this framework, the first step for the teacher is to identify some suitable tasks, whether from instructional materials or from some other source.

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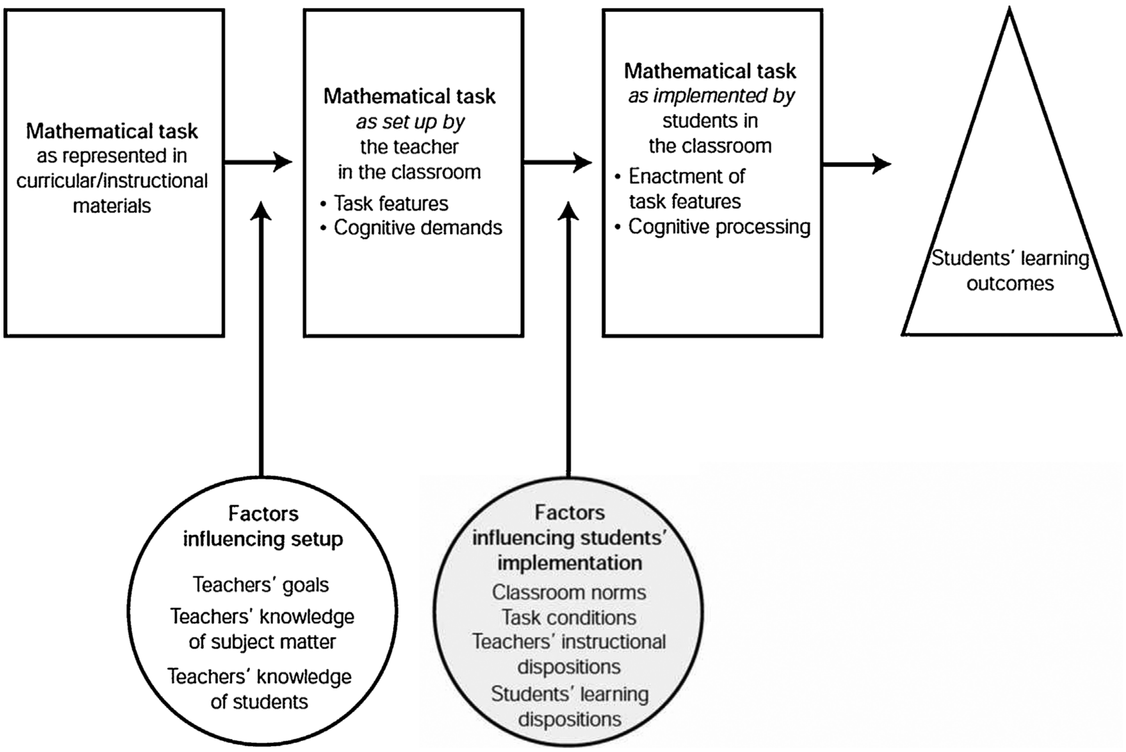

Fig. 1. Relationship among various instructional task-related variables and student learning.

In addition, Sullivan (2011) argued that

> It is critical that teachers are mindful of the pedagogies associated with the task, and are ready to implement them. The process of converting tasks to learning opportunities is enhanced when students have opportunities to make decisions about either the strategy for solving the task or the process they will adopt for addressing the task goal or both. … It is only tasks with such features that can stimulate students to engage in creating knowledge for themselves. (p. 31)

In the remainder of the paper, we will consider a rationale for contextualized tasks, exemplary tasks, affordances and constraints of contextualized tasks, and the discussion of several of the instructional task-related variables from Fig. 1, all relevant to the development and implementation of *contextualized tasks*.

2. A rationale for tasks built around practical contexts

It is widely acknowledged that as students progress through schooling, many come to dislike mathematics, seeing it as irrelevant (Grootenboer & Marsham, 2016). As part of the Australian Mathematics Curriculum and Teaching Program (Lovitt & Clarke, 1988), teachers in all Australian states and territories were asked to identify their concerns about the teaching of mathematics in the middle years. Common responses were: mathematics was seen by many students as boring and irrelevant; little thinking was involved; the subject was too abstract; student exhibited a fear of failure; too much content was covered in too little depth; assessment was narrow; and it was a huge challenge to meet the needs of a wide range of abilities. Readers can judge whether the same comments can be made of mathematics teaching today, but the topic of this paper relates clearly to responses to the first criticism (by students and teachers) that school mathematics is seen as boring and irrelevant.

Those who support the use of contextualized tasks suggest benefits such as enhanced motivation of students, as students see the ways in which mathematics can help us make sense of the world (see, e.g., Meyer, Dekker, Querelle, & Reys, 2001). Proponents of Realistic Mathematics Education (RME) from The Netherlands advocate the use of contextualized tasks, but rather than emphasize motivation from real life contexts, they focus on providing learning situations that are *experientially real* for students and a springboard for advancing understanding (Gravemeijer, 1997). In their view, the task must require students to "imagine the situation or event so that they can make use of their own experience and knowledge" (van den Huevel-Panhuizen, 2005, p. 3). See also Mason (2016) for a further elaboration of this perspective.

The lesson *Licorice Factory,* in which an imaginary factory stretches unit length licorice to any length, while introducing students to prime numbers in the process (Lovitt & Clarke, 1988), is an example of a lesson that is real in the sense that students can imagine the situation, and the mathematical concepts which emerge from this imagination.

Turner and Font Strawhun (2007) wrote of the power of problems of a very personal nature, such as school overcrowding. They