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# Perceptions of social issues as contexts for secondary mathematics

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## ABSTRACT

This paper investigates pre-service secondary teachers' perceptions of learning and teaching mathematics through extended explorations that are contextualized in issues of social importance. The study is situated within a research program concerned with mathematical knowledge used in, and useful for, teaching, and how such knowledge may be fostered in teacher education programs.

## 1. Introduction

This paper investigates pre-service secondary teachers' perceptions of learning and teaching mathematics through extended explorations that are contextualized in social issues. The study is situated within a research program concerned with mathematical knowledge used in, and useful for, teaching, and how such knowledge may be fostered in teacher education programs.

Part of the motivation for this study relates to the observation that how mathematics is contextualized in school can offer students a window into its real world applicability; it can suggest for whom and how mathematics is needed and useful. Conventional contexts tend to include fields such as sciences, economics, or engineering, though there is growing advocacy for applying mathematics to issues of social importance. Indeed, the majority of secondary school pupils will not go on to complete mathematics degrees, yet as Hughes-Hallett (2015) discussed, many professionals, such as lawyers, judges, policy-writers, need to use mathematics in order to make sense of data related to equity issues (such as stop-and-frisk) and the implications of that data, and they struggle to do so. Such use of mathematics is not necessarily straightforward, and requires experience and mathematical understanding. This highlights the need for teachers to hold a broad awareness of relevant mathematical applications in their considerations of how to best prepare their students.

This study introduces the construct of *social justice context problems* (hereafter referred to as SJcp). Briefly, these may be thought of as extended explorations that require mathematical problem solving to explore, analyse, critique and make sense of socially relevant situations. The learning intentions behind the SJcp include encouraging growth in mathematical understanding of specific content, its real-world applicability, and its relevance for understanding, unpacking, and critiquing social issues and their implications. A detailed discussion of how these were conceived, designed, and structured, as well as a description of the specific tasks used in this study is presented in Section 4 of this paper and draws on task design constructs for teacher education (Liljedahl, Chernoff, & Zazkis, 2007) and social justice (Gutstein, 2006). Research focused on participants' perceptions of learning mathematics via their engagement with SJcp, as well as on their perceptions of incorporating similar learning tasks in secondary school teaching. Mason (1998) theory of awareness was used as a lens through which to analyse participants' reflections on their own mathematical activity and on the suitability of social contexts for school mathematics learning. Results are analysed and discussed with respect to the research goals of this study and their implications for teacher education.

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## 2. Background

There is an extensive body of literature focused on mathematics for social justice, whose research scope is different (and arguably more important) than that of this paper. Research regarding social justice and mathematics has included, for instance, exploring classroom dynamics with respect to class, gender, identity, and ethnic equity (e.g., [Gutierrez, 2013](#); [Mendick, 2003](#); [Shockey & Gustafson, 2007](#); [Zevenbergen, 2003](#)), developing critical mathematical competencies for understanding the world and empowering oneself (e.g., [Gutstein, 2006](#)), developing meaningful and responsive pedagogy in multicultural settings (e.g., [Bateiha, 2010](#); [Ladson-Billings, 1995](#)), and confronting institutional inequities to liberate oneself from oppression (e.g., [Gonzalez, 2009](#)). The aims of this research were focused specifically on perceptions of learning mathematics through its application in contexts of social relevance. Thus, for the purpose of this paper, we restrict attention specifically to studies which attend to learning mathematics through tasks that contextualize curricular material in social issues and some of the related pedagogical challenges.

Most examples from the mathematics education literature focus on middle school mathematics and have included statistical analyses of unemployment (e.g., [Frankenstein, 2006](#)) and incarceration rates (e.g., [McGee & Hostetler, 2014](#)), as well as cost analyses of defence funding ([Stocker, 2006](#)), slavery (e.g., [McGee & Hostetler, 2014](#)) and globalization (e.g., [Esmonde & Quindel, 2006](#)). Researchers and teachers who have incorporated social issues as contexts for mathematics learning have done so with different pedagogical intentions. For instance, [Frankenstein \(2006\)](#) developed a task which involved exploring real data to disentangle complexities around unemployment rate statistics, while [Esmonde and Quindel \(2006\)](#) used made-up data to smooth out complexities involved in understanding issues of globalization and costs of labour. These differences reflect some of the tensions in teaching through such contexts.

Indeed, contextualizing mathematics in social issues can be quite contentious. Balancing pedagogical goals aimed at fostering mathematics learning, and social understanding, respectively, can be challenging for both novice (e.g., [Bartell, 2013](#); [Garii & Rule, 2009](#)) and experienced teachers (e.g., [Gutstein, 2006](#); [Nolan, 2009](#)). There are concerns that debate around the social issues may take precedence over the mathematics learning (e.g., [Wager & Stinson, 2012](#)), or that the social issue is inadequately explored (e.g., [Bartell, 2013](#)), and there are examples of where neither the mathematics nor the social issue are sensibly or appropriately addressed (e.g., [BBC, 2017](#)). Indeed, classroom practices tend to fall short of realistic ones, even in more conventional fields of application (e.g., [Moschkovich et al., 2002](#)). Helping prepare teachers to incorporate social issues as mathematically rich and well-balanced contexts for investigation requires extended research attention. One such research avenue concerns teachers' perceptions of learning and teaching with socially relevant contexts and their abilities to articulate – for students, colleagues, parents, administrators – how mathematics objectives can be met via such contexts. Taking a step in this direction, this study draws on [Mason \(1998\)](#) constructs of awareness, which enable articulation of mathematics and mathematics pedagogy, are used to analyse participants' perceptions of the mathematical activity elicited by the SJcp and the potential suitability of such problems in their future teaching.

## 3. Theoretical framework

[Mason \(1998\)](#) theory of awareness for mathematics teaching provides a framework through which to analyse participants' perceptions about learning and teaching mathematics through the use of social justice context problems. [Mason \(1998\)](#) characterizes three different, but related forms of awareness:

- *Awareness-in-action*: the ability to act in the moment. This relates to knowing what to do in a given situation, but not being aware of why that action was taken. In teaching, this could be seen when a teacher describes a process, corrects a mistake, or answers a question, but is unable to justify it.
- *Awareness-in-discipline*: awareness of awareness-in-action. This includes understanding of why certain actions were taken in a given situation, why certain ideas are true, and an ability to articulate the 'why'. In teaching, it allows for the articulation of choices made during instructional situations, and is essential in articulating awareness-in-action.
- *Awareness-in-counsel*: awareness of awareness-in-discipline. This includes a sensitivity toward what others might require to enhance their own awareness(es). If awareness-in-action is awareness of what to do, awareness-in-discipline of why to do it, then awareness-in-counsel can be thought of as awareness of how to do it along with an ability to articulate the 'how'. It is essential in articulating awareness-in-discipline for others.

Mason describes awareness-in-action as "powers of construal which everyone who walks and talks has displayed in profusion" (1998, p.257). It includes powers of selecting, distinguishing, discerning; powers to see similarity, to abstract, imagine, and manipulate; to link, visualize, and so on. It is possible to act with these powers without being aware of it, particularly if the powers have been developed in routine situations that have not needed "innovation, novel interpretation, or creativity". Mason explains that education is about more than training in routine actions, and awareness of what we do allows us to re-construct, modify, and adapt our actions and "above all, to know-to act when it might be appropriate" (1998, p.258). For instance, if an individual is asked to provide a "best route for travel" and knows-to optimize costs, distances, and so on, this can be seen as awareness-in-action. If the individual is able to articulate that is what he or she is doing and understands why the question is one of optimization, then this is recognized as awareness-in-discipline – the individual is aware of his or her awareness-in-action. Awareness-in-discipline can be fostered through, for example, tasks which promote the use of certain techniques while at the same time drawing attention away from those techniques – [Mason \(1998\)](#) suggests this as a way to help automate those techniques while drawing attention toward situations in which the application of those techniques are appropriate. Finally, if the individual is aware of, and can articulate, how

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