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Supporting statistical literacy: What do culturally relevant/realistic tasks show us about the nature of pupil engagement with statistics?

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ABSTRACT

The Portuguese curriculum has recently moved away from a focus on individual subject disciplines towards the development of cross-disciplinary competencies for civic life, including the development of statistical literacy in application to everyday problems. Students are encouraged to draw on their own interests to collect and organize data sets in support of intra- and inter-disciplinary problem solving, reasoning and communication. In this paper we investigate this conception of the development of statistical literacy and its relation to 'real life' by exploring the talk of three pairs of working-class Portuguese students engaged in a task that was considered to be culturally relevant and realistic, and hence supportive of the development of civic competencies. We analyse what the nature of their talk indicates about the role of identities and dispositions in the way they approach statistics and their application in the real world. We suggest that differences between how each pair of students engages with the tasks illustrate the importance of individual experience and identity in accessing important statistical literacy.

1. Background

A gradual transformation of the Portuguese education system since 1986 has involved a move away from subject- and year-specific curricula towards an emphasis on the development of essential competences considered to be fundamental knowledge for modern citizens. This 'multiple literacies' approach is reflected in the new curriculum focus on a set of principles which include among others "participation in civic life in a free, responsible, jointly liable and critical manner [and] valuing of different forms of knowledge, communication and expression. . ."; competences are thus seen as "knowledge in use, necessary to the quality of the personal and social life of all citizens" (DEB, 2003, p. 15). More specifically, citizens should be able to "mobilize cultural, scientific and technological knowledge in order to understand reality and to deal with situations and problems common to daily life" (DEB, 2003). The development of competences so described assumes interaction and convergence between curriculum areas. Thus teachers are charged with the task of focusing on how individual subject characteristics can be drawn on to foster students' abilities to question reality, identify the knowledge required for dealing with problems common in daily life, and assess the appropriateness of knowledge and procedures (pp. 15–16).

One potential vehicle for the development of such competences is engagement with statistics. This is a clear topic in the mathematics curriculum of many countries (Garfield & Gal, 1999) and Portugal is no exception. Adjustments to the Portuguese mathematics curriculum in 2007 (DEB, 2007) endowed "Organisation and Data Processing" with the distinct role of supporting statistical literacy through links with cross-cutting skills of problem solving, reasoning and communication. It

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is in this sense that the Portuguese curriculum aims to use the discipline of mathematics to contribute to students' personal development, providing them with the mathematical training necessary to support other disciplines and the continuation of study beyond the compulsory years, as a vital component in social and lifelong learning. In practice this has come to mean that the curriculum aims to emphasize students' real life interests through the collection and analysis of data sets as a basis for their work. Already present in the curriculum in the '90s but more explicitly stated in 2007 this approach is seen as an opportunity to promote interdisciplinary activities as a part of thematic learning across subjects, and also intradisciplinary learning (by enabling links between statistics and other areas of mathematics including fractions or proportionality; number patterns; geometry; and scale). In this paper, we focus on students' (critical) understanding of the use of statistics within the Portuguese cross-disciplinary curriculum, problematising the assumptions lying behind these general curriculum developments through a micro-level focus on students' talk as they engage with an embedded statistics task.

1.1. Statistical literacy and social justice: making sense of ideas in the school context

Many peoples' lives are regulated by numerical indicators. As Nisbett, Krantz, Jepson and Kunda (1983) pointed out some time ago, 'statistical reasoning is the culturally prescribed way to think about randomizing devices in our culture' (p. 346). This remains true: to have statistical knowledge and understanding and the ability to interpret the numbers that surround us is a crucial part of exercising citizenship which is reflexive and participatory, since, collectively or individually, we are all called upon to make choices based on the analysis of data. Thus it would seem that statistics could and should take a central role in connecting everyday life and mathematics, not merely because of the frequent references to statistics in regular consumer practices such as shopping and money management, or in sports and the weather, for example, but also because of their occurrence in science and politics debates, where the development of a critical approach to statistics and their use in dominant discourses is a social justice issue. However, despite the ubiquity of statistics (and of course mathematics in general) in everyday life, a major feature of recent research in access to mathematics concerns the extent to which schools can capitalize on connections which are rooted in lived experiences of the application of mathematics. The frequency of occurrence of statistical terms concerning averages or means in reference to typicality and distribution in everyday life does not necessarily make them accessible, and indeed research reports that they are notoriously misunderstood (e.g. Jacobbe & Carvalho, 2011; Leavy & Middleton, 2011).

Attempts to increase access to mathematics focus on a variety of approaches which are based on different conceptions of the problematics involved. Frequently, word problems embed mathematics in familiar everyday situations which are not normally described in mathematical terms, making literacy demands which have been shown to differentiate between pupils in terms of social class and ethnicity. So, for example, Cooper and Dunne (2000) report that working-class students perform as well as middle class students on decontextualised mathematical tasks, but drop behind on embedded tasks despite the fact that these are commonly assumed to be 'easier' as a result of their use of 'real life' situations. Working class pupils are more likely to import 'inappropriate' everyday knowledge into their solutions to 'realistic' problems, because 'the sense of the "obvious" or the "appropriate" has to be learned, either in the home or the school' (Cooper, 2001, p. 248). Lubienski (2007) found that 7th-grade lower socio-economic-status students struggled with contextualized problems for similar reasons: while taking real-world variables into account, they missed 'the generalized mathematical point'; in contrast, 'the higher-SES students were more likely to approach the problems with an eye towards the intended, overarching mathematical ideas' (p. 18).

Moving from assumed realism to genuine relevance, many researchers argue that mainstream mathematics curricula privilege the dominant culture at the expense of marginalised groups, sidelining local knowledges, contexts and pedagogic discourses. This is a particular focus for those concerned with increasing mathematics options for indigenous peoples (see for example Lipka et al., 2005) and for minority ethnic groups (for example Civil, 2007; Gutstein, Lipman, Hernandez, & de los Reyes, 1997; Sharp & Stevens, 2007), but it also applies in the context of social class (see Ensign, 2003; Frankenstein, 1995). A culturally based mathematics curriculum creates a dialogic 'third space' (Gutiérrez, Rymes, & Larson, 1995) in which teacher and student interests cross over, as in Nasir's (2007) work on 'basketball mathematics' as a strategy which supports and validates African American students' identification with mathematics. Nasir argues that the students' experience of, for example, comparing a player's statistics to a norm or a standard, enabled them to connect the objectivity of numbers with qualitative judgments, thus contextualizing them and generating stronger understanding. More generally, Lavigne and Lajoie (2007) found that although grade 7 children understood a survey enquiry process, their statistical reasoning 'tended to be naive' (p. 659). They argue that 'given that learners' personal interests drive their inquiries we need to assist them to better integrate these interests with statistical content' (p. 660).

An extension of culturally relevant mathematics argues that students need to engage with and develop tools for *critical* mathematical thinking which considers the role of mathematics in the world and our relation to it (see Gutstein, 2006; Gutstein et al., 1997). For Frankenstein (1994, p. 22), 'criticalmathematical (sic) literacy involves the ability to ask basic statistical questions... understanding that political struggles/choices are concealed in supposedly neutral statistical descriptions of our world; understanding how numerical data can explode the myths about the institutional structure of our society...'. Similarly, for Gutierrez (2007), a 'critical mathematics takes students' cultural identities and builds mathematics around them in ways that address social and political issues in society, especially highlighting the perspectives of marginalized groups' (p. 40).