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The contextual power dynamics in defining and utilising problem solving tasks: A case study at an Egyptian private school

Mariam Makramalla¹ and Andreas J. Stylianides²

¹University of Cambridge, Faculty of Education, United Kingdom; mmmm2@cam.ac.uk

²University of Cambridge, Faculty of Education, United Kingdom; as899@cam.ac.uk

This paper builds on Ernest's five ideologies for mathematics education in order to explore the socio-cultural buy-in of mathematical problem solving tasks within the context of private schools that are governed by the Egyptian national mathematics curriculum. The research contributes to the contextual understanding of teacher beliefs and school power dynamics that affect the adoption or rejection of a culturally foreign teaching ideology of problem solving. Findings from one teacher focus group revealed that the teachers had a good understanding of the features that align with a literature-based classification of problem solving tasks. Yet, a disparity was found between desired and existing best practices for classroom implementation of problem solving tasks. This disparity is argued to be a function of power tensions between inner and outer circles of contextual influence.

Keywords: problem solving, socio-cultural power tensions, educational ideologies, teacher beliefs

Introduction

Literature argues against school education being viewed as a neutral enterprise (Apple, 2004). The skill and knowledge dissimilation process in schools is arguably better understood when viewed from the perspective of the schools' position in a dynamic and turbulent context that incorporates complex social and cultural power relations (Bernstein, 1971). This study explores the specific context of mathematics instruction at Egyptian private schools that teach the national curriculum. As will be elaborated further in the upcoming sections, this context is particularly interesting as it embodies – at the private school level – a teaching culture that appreciates an inquiry-based enactment (Apple, 2004) of the mathematics curriculum. This culture is however situated and controlled by an imposed national curriculum agenda that is rather stagnant and one-sided in nature (Hargreaves, 1997; Naguib, 2006). The study aims to unravel the mentioned inner and outer circles of influence and how these play a role in shaping mathematics teachers' beliefs and practices, particularly in relation to their teaching of mathematical problem solving.

Literature Review

Literature claims that social and cultural configurations govern the outcome of schooling in order to ensure the reproduction of an existing culture of stratified social class relations (Apple, 2004). In line with that view, Alexander (2000) unpacks the term 'education' and focuses on three particular aspects, namely curriculum, assessment and inspection. He claims that the formation of those is bound by different forms of policy and power. Our study focuses on the first element and argues that, since education cannot be viewed as a neutral enterprise, similarly curriculum design and knowledge distribution schemes cannot be viewed as neutral. According to Apple (2004), curriculum design and enactment which govern the process of skills formation and cultural capital

distribution (Bourdieu, 1986) are controlled by power dynamics that relate to a given context's social class hierarchy.

Particularly in relation to science and mathematics curricula, literature suggests that the general tendency to move towards a curriculum design where students are taught to become independent inquirers is often quenched by a culturally selective curriculum enactment tradition where educators may choose to teach certain skills or forms of knowledge in order to re-enforce certain configurations of social power. This selective tradition, which in turn is governed by social and cultural power dynamics, can be better understood when considering the historical roots that led to its formation (Apple, 2004; Bourdieu, 1986).

Scholars (e.g., Alexander, 2000; Apple, 2004) have added to the discussion about forces affecting curriculum design and enactment the dimension of political control. In his comparative study on primary education in five different cultures, Alexander (2000) claims that the national constitutional identity plays a vital role in prescribing curriculum outlines and elevating certain forms of knowledge and skill transfer over others. According to scholarship, to better understand the question of political control, the question of centralizing (or de-centralizing) systems of curriculum design and enactment is crucial to consider (Alexander, 2000).

In light of that understanding, we intend to map the situation of primary stage mathematics curriculum enactment and design in Egypt. A wider study from which this work is derived has elaborately addressed, drawing on relevant literature (Heyworth-Dunne, 1968; Sika, 2010), the historical evolution of education in modern Egypt. It sought to map out social and cultural configurations and power tensions against educational outcomes of skills and cultural capital distribution. While it is beyond the scope of this work to elaborately address the overall historical mapping of education in modern Egypt, we consider it as important to use sections of that mapping, particularly to better understand political and social control forces governing the purpose and identity of curriculum enactment and formation. In light of Alexander's (2000) views about political control, it is worth mentioning that, since the republic of Egypt was formed in 1953, curriculum design and enactment agendas have been standardized. A centralized system that is governed and tightly controlled by the Ministry of Education (MOE) strategically selects the forms of knowledge acquisition and skill transfer that are to be enacted by the national curriculum to all schools of Egypt. Literature (Naguib, 2006) shows that for the case of the mathematics curriculum the focus is on factual knowledge and the transmission of a one-sided set of facts that are not to be questioned or debated. Mathematics instruction is meant to take on the form of a procedural, teacher-led, exam-oriented structure (Sika, 2010). The national curriculum in Egypt is taught in all public schools and also in the so-called 'national curriculum private schools'. Both forms of schooling stem from different social, cultural and historical roots (Heyworth-Dunne, 1968). The historical plotting, referred to earlier, indicates a so-called cultural migration (Alexander, 2000) of educational values which governed the original institution of foreign private schooling, even before the republic of Egypt was formed. Those values are centered around a more multi-façade, student-centered scheme for curriculum enactment. Nevertheless, being under the governance of the MOE, a centralized system ensures that the curriculum enactment follows the same format across all types of national schools in Egypt (Hargreaves, 1997; Naguib, 2006; Sika, 2010).

Alexander (2000) claims that schools are micro-cultures mediating imposed curricula in such a way that reflects some of the school's own flavor. It is true that, despite the fact that the same mathematics curriculum is meant to be applied across the mentioned wide base of schooling, curriculum enactment remains quite a complex process (Remillard & Heck, 2014). This paper presents a case study that addresses the interplay between a centrally governed curriculum and its contextual enactment in the culture of a private school. More specifically, we will focus on how the factual nature of the national mathematics curriculum translates into the formation of teacher beliefs about problem solving and how in turn these beliefs affect, according to the teachers, their curriculum enactment decisions in the classroom. The research questions to be addressed are the following:

- (1) Within the context of a private school in Egypt that is bound to follow the national curriculum, how do school mathematics teachers perceive features of problem solving tasks?
- (2) Within this same context, how do school mathematics teachers view the contextual suitability of adopting their perceived problem solving tasks into their local teaching setting?

Theoretical Framework

In his model of educational ideology for mathematics, Ernest (1995) situates the wider aims of mathematics education along with the specific function of school mathematics teaching, learning and assessment within a context that is bound by the theory of society, the theory of the child and the moral ideologies attached to a given society. Ernest (1995) differentiates between five educational ideologies in viewing teaching and learning mathematics and maps those out against cultural power configurations in society. He views these ideologies from various social and pedagogical perspectives. Three of those perspectives form the theoretical grounding of this paper (Figure 1).

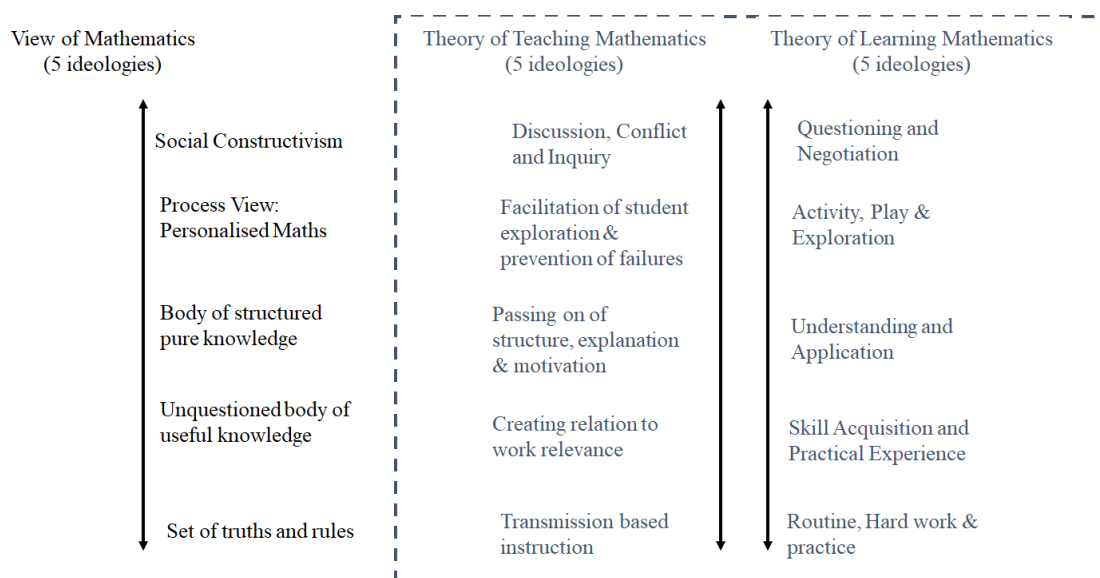


Figure 1: Mathematical ideologies: Three perspectives (adapted from Ernest, 1995)

As illustrated in Figure 1, it is not possible to dissociate a teacher's perception of mathematics, which in turn translates into a teaching and learning theory, from the student's experience when

learning mathematics and from the wider nature of viewing and experiencing mathematics both by the teacher and by the student. Figure 1 shows how five different mathematical ideologies manifest themselves in the experience of the teacher and the learner. These ideologies extend all the way from viewing mathematics as a set of fixed truths and teaching it in a rather authoritarian and transmission-based mechanism all the way to viewing mathematics as a subject of constructive nature and the teaching of it as being rather more inquiry- and discussion-based. In turn, the learning of mathematics is viewed as lying on a spectrum that extends from the mastery of formulas and procedures on the one end to the learning of inquiry skills and negotiation on the other end. Ernest's (1995) discussion of the latter features align broadly with our understanding of problem solving skills as discussed in the literature (Schoenfeld, 1992; Stein, Smith, Henningsen, & Silver, 2000).

Various scholars (Polya, 1945; Schoenfeld, 1992) have sought to conceptualize mathematical problem solving as a construct and apply that understanding in the formulation of mathematical tasks. As an extension of the scholarly view that perceives mathematics as ranging from the pure application of rules on the one side of the spectrum to problem solving on the other (Schoenfeld, 1992), Stein et al. (2000) identified four types of mathematical tasks: memorisation tasks, procedures without connections tasks, procedures with connections tasks, and doing mathematics tasks. While we acknowledge that the term "problem solving" has been used in different ways in the literature (Schoenfeld, 1992; Reiss & Törner, 2007), for the purpose of this work we have adopted Stein et al.'s (2000) perspective on problem solving which, at the task level, has been conceptualized by the authors as "doing mathematics tasks" (p. 16). According to the authors, doing mathematics (or problem solving) tasks are unique in that they invoke student analysis based on conceptual understanding of the underlying mathematical principles, their solution process has an unpredictable nature and a high level of ambiguity, they place on the solvers high cognitive demands and they require solvers to self-regulate their thought process. The broad understanding of the ideologies that formulate a teacher's and a learner's view of mathematics along with the specific unfolding of that view in the form of mathematical tasks constitute the foundation to conceptualizing the upcoming analysis.

Methodology

As part of the larger project exploring contextual power dynamics in relation to framing teacher perceptions of mathematical problem solving, this research adopts the methodology of a multiple case study, conducting various focus groups across a wide range of private schools in Egypt. It is worth mentioning that, in Egypt, private schools annually serve a wide base of students (approximately two million) from various sociocultural family backgrounds (CAPMAS Yearly Report, 2017). The case studies have been carefully selected to represent the high end, the low end, and the middle of the socio-cultural map of private schooling. Each case study represents findings of two focus groups conducted at different schools that are both classified within the same socio-cultural cluster of schooling. In the following, we present findings from one focus group that has been classified by local partners as lying on the high end of the private schooling spectrum. This classification has been also confirmed based on an assessment of the school location, the school fee

and the selection criteria of both students and teachers. The sample comprised a group of six mathematics teachers.

Being a contextual study, it was important that the method selected was locally fitting. Researchers have investigated the suitability of using focus groups as a research method in the Arab context and have argued that focus groups are well received by participants (Thomas, 2008). Being a collective culture (Thomas, 2008), teachers' choices and practices are governed and influenced by each other's perceptions making it unlikely for a teacher to adopt a practice in their classroom if it is not collectively perceived as best practice by most other teachers. Hence group power dynamics represented a cultural reality that needed to be taken into consideration.

The data collection protocol was framed around prompts of a Task Sorting Activity (Friedrichsen & Dana, 2003) followed by a more holistic focus group discussion. For the Task Sorting Activity, eight tasks were put together ranging across Stein et al.'s (2000) mathematical task spectrum. The tasks showed an interesting variation in terms of their presentation, including numerical tasks, word problems, and visual integration tasks. The participating teachers were unaware of the existing task pre-classification and were prompted to classify the eight tasks according to (a) which tasks they considered to be problem solving tasks (cf. RQ1) and (b) which tasks they would be more likely to use in their classrooms (cf. RQ2). Each of the sorting prompts was followed by a more elaborate focus group discussion about teachers' task sorting choices.

The data analysis followed an inductive data-driven approach. Incidents in the data demonstrating task features that were associated by teachers to problem solving tasks (cf. RQ1) were grouped together to form codes and clusters. Based on the constant comparative method (Glaser, 1965), the coding scheme was developed over three levels of analysis. First, incidents in the data were compared to each other. More specifically, three different focus group transcripts were chosen representing low, high and middle socio-cultural levels. Incidents in those three transcripts were cross-compared and clustered to create a preliminary coding scheme representative of all three sets of data. Secondly, the created code was compared to another set of incidents, represented by three other focus group transcripts also varying across socio-cultural standings. Resulting from that was a more elaborate coding scheme. Finally, created codes were compared against each other, yielding a saturated format of codes and clusters. This saturated code was then utilized for the frequency count analysis of all focus group transcripts. Occurrences in the transcripts that aligned with the codes in the saturated coding scheme were counted in order to trace the popularity of certain task features. Following the same method, a separate set of codes was created to represent task features that teachers perceived to be suitable for their local classroom practices (cf. RQ2) given the constraints of the national curriculum framework. Contrasting the findings obtained from these two sets of codes cast some light on the power tensions between teacher perceptions and the contextual reality.

Findings

Results of the analysis revealed the following task features to be most popularly associated by teachers with problem solving tasks:

Nature of the task: The task layout has to be relevant to students' everyday lives. Also, the task needs to be approachable by a range of different methods, thereby giving space for a wide audience of learners to address the task, each in their own way.

Teaching the task: Students need to independently tackle the task, thereby exploring new and often unfamiliar territories. However, the teacher needs to be in tight control of that exploration process.

Learning from the task: In order to solve the task, students would need to go through an inductive process, to develop a yet unknown formula or solution procedure, that can then be adopted to find the solution to the problem. This creative process of invention was said to be cognitively demanding and was argued to naturally trigger student enjoyment.

These results show a high degree of alignment of teacher perceptions of problem solving task features with Stein et al.'s (2000) conceptualization of problem solving tasks (referred to as "doing mathematics tasks" in their classification). Indeed, teachers seem to agree with the literature about the knowledge creation process that ought to be triggered in students' minds as they engage in problem solving tasks.

When asked about the suitability of adopting such tasks in the classroom, teachers admitted that these tasks would not naturally align with the national curriculum agenda. Yet, they also made it clear that they would favor adopting this type of tasks over the tasks that fulfil the national curriculum textbook requirements. The teachers described the latter kind of tasks as follows:

Nature of the task: The task layout has to be tangible and relevant to students' everyday lives. Its formulation needs to be straightforward and needs to align with the formulation of expected examination questions.

Teaching the task: The teacher presents to the students the task solution process. This is often coupled with a more elaborate explanation of the concepts that relate to that solution process. Students are encouraged to follow teacher explanations and ask questions.

Learning from the task: The task needs to be quickly and easily solvable by an average student.

When contrasting the two descriptions of task features, we see a gap between (1) the kind of tasks that align with the curriculum requirements and that the teachers perceived to be suitable for local adoption and (2) the kind of tasks that the teachers perceived to be problem solving tasks and would rather enact in their classrooms if they were given the choice. Figure 2 maps our classification of the two aforementioned task types on to the framework developed in Figure 1. The symbols (x) and (*) have been used to mark the position of the first and second kind of tasks, respectively.

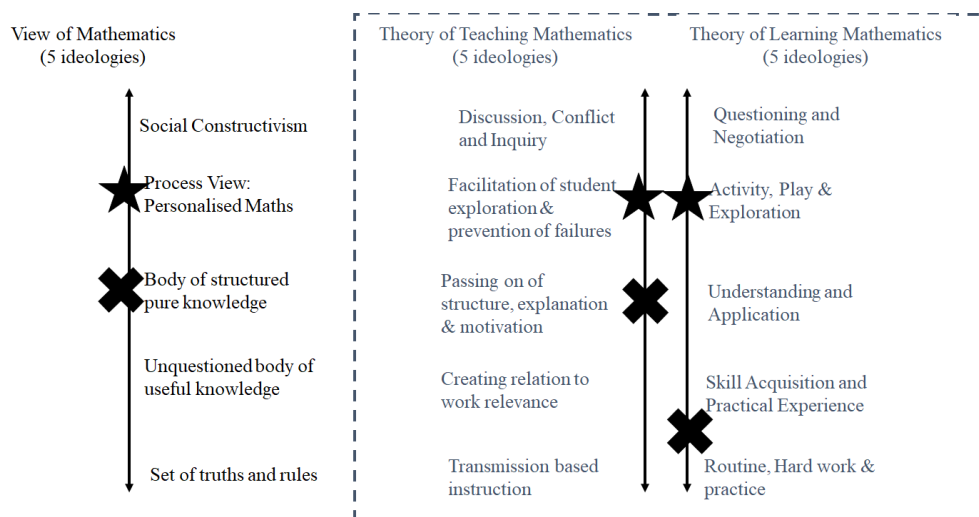


Figure 2. Mapping of findings

As illustrated in Figure 2, there seems to be a variation between the ideology that the curriculum dictates and the mathematical ideology that would rather be implemented by the teachers and that in their view relates to problem solving. In their focus groups, teachers commented about them being governed by a one-size-fits-all curriculum model that does not align with their own views about mathematics. They also argued to be bound by a narrow time schedule that is dictated by the national curriculum requirements which results in them mostly having to enact a rather more procedure-based (Stein et al., 2000) mathematics view in their teaching.

Nevertheless, the discussion still revealed traces of teachers attempting to enact their own mathematical ideology in the classroom despite being bound by a different curriculum ideology. Teachers expressed their belief in the importance and relevance of integrating into their teaching the tasks that they defined to be problem solving tasks. Being foreign to the national curriculum, it would be difficult to integrate this type of tasks as a student-led activity. Nevertheless, teachers claimed that those tasks could still be useful as a pedagogical tool to introduce students to new mathematical concepts and to involve them in the development of formulae and procedures in relation to those. In that way, the teachers' definition of a problem solving task experience would be partially fulfilled. The task would trigger knowledge construction, yet it would only serve as a teacher explanation tool.

Discussion

In response to the research questions about teacher perception and enactment of problem solving within the context of the mathematics national curriculum, the following can be stated:

- (1) Teacher perceptions about mathematical problem solving seem to align more with the ideology that is found in literature (Stein et al., 2000) rather than with the ideology that is dictated by the curriculum (Naguib, 2006; Sika, 2010).
- (2) In view of curriculum enactment, the ideology dictated by the national curriculum seems to have superiority on classroom enactment choices when compared to teachers' ideological preferences. Nevertheless, there is some evidence of a partial realization of problem solving task integration in the classroom, which aligns more with teachers' preferred ideology.

These results re-emphasize the indicated gap between the inner and outer circles of culture and contextual influence. In line with the plotting at the onset of this paper, the historical roots of cultural migration that led to the formation of a different cultural footprint of foreign private schooling in Egypt seem to still have an impact on teacher belief formation and desired curriculum enactment practices. As the results indicate, teachers seem to be more oriented towards inquiry-orientated curriculum enactment practices. Despite the fact that the mathematics curriculum in Egypt is meant to be centralized around schemes dictated by the MOE and that its enactment is meant to be unified across all national Egyptian schooling types, the investigation of the actual enactment seems to offer more variety and complexity. Findings of this study indicate some traces that re-emphasize Alexander's (2000) views of schools being microcultures transferring their own cultural flavor. As the findings indicate, teachers seem to find it important to integrate problem solving tasks into their daily instruction, even if those do not align with requirements of the national curriculum. Results also indicate an apparent power dynamic that gives superiority to the influence of the national curriculum ideology, resulting in teachers' mathematical ideologies being trapped and only being partially realized in terms of practical enactment in the classroom. This superiority seems to only influence the practical enactment, yet it seems not to affect the formation of teacher beliefs about mathematical problem solving. Findings reported in Figure 2 also indicate a disparity between the national curriculum's views of teaching and those of learning mathematics. While teaching mathematics seems to be associated with the teaching of structures, the learning of mathematics was associated by teachers as a routine process of recalling knowledge. According to Ernest's (1995) framework there seems to be a mismatch between both views that is worth investigating in future research.

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